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THE UNIVERSITY OF ALBERTA

PERFORMANCE AND IMPACT OF AN ALFALFA PROCESSING PLANT

BY

ELIJAH KAGANGARI BUSINGYE ©

A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES AND
RESEARCH IN PARTIAL FULFILMENT OF THE REQUIREMENTS
FOR THE DEGREE OF
MASTER OF SCIENCE

DEPARTMENT OF RURAL ECONOMY

EDMONTON, ALBERTA
(SPRING), (1976)

UNIVERSITY OF ALBERTA

FACULTY OF GRADUATE STUDIES AND RESEARCH

The undersigned certify that they have read and recommend to the Faculty of Graduate Studies and Research for acceptance a thesis entitled "Performance And Impact Of An Alfalfa Processing Plant", submitted by Elijah Kagangri Busingye in partial fulfilment of the requirements for the degree of Master of Science.

L.P. Apedaile
Supervisor

Melville McMillan

Date 21 April 1976

ABSTRACT

Alfalfa is recognized as a valuable protein crop. But the conventional harvest as hay is so bulky and subject to protein loss, that it has restricted market opportunity. Therefore, processing by dehydration and pelletising has recently been encouraged in the Province of Alberta.

This thesis attempts to examine the following: (1) the financial viability of the Smoky Lake Alfalfa Processing Plant, and (2) the competitive impact of alfalfa production in the county of Smoky Lake. Examination of financial viability is tied to the concepts of cash flow analysis, linear programming is used to study possible impacts on farm enterprises of alfalfa.

In this study, financial viability requires that the financial rate of return be more than the market rate of interest. The procedure involved cash flows projections of the Smoky Lake plant for a planning period of fifteen years. The computations yielded a return of 15.2 percent. Sensitivity analysis varying throughput as a percent of capacity and varying price provided a test for vulnerability of the earning capacity of the plant.

The competitive impact of alfalfa production, was estimated using a general Linear Programming Model for Northern Alberta augmented by several alfalfa production activites obtained from a sample survey of alfalfa growers in Smoky Lake County. Corresponding constraining equations for the County were defined. A IBM mathematical programming system was used for manipulation of the problem toward a solution. The conclusion was reached that the production of alfalfa for processing purposes would not have a significant impact on the cropping and livestock patterns in Smoky Lake County.

ACKNOWLEDGEMENTS

The writer wishes to express appreciation to those who provided assistance in the preparation and completion of this study. Grateful recognition is extended to the Alberta Department of Agriculture and Canadian International Development Agency for financial support. There can be no doubt, however, that the chief debt is owed to Dr. L.P. Apedaile who supervised the research and kept prodding me to complete this thesis.

Appreciation is also due to Mr. Ronn Bence for technical assistance and Mr. A.Y. Bobe for the encouragement. Many thanks are due to the typist, Mrs. Helen Kuzyk who worked through several drafts of the manuscript and to Miss Evelyn Shapka for literary corrections.

Above all, I would like to thank my parents, sisters and my daughter for sacrificing so much.

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CHAPTER I

Agricultural Processing Concepts

Alfalfa processing is an integral part of the policy of agriculture and rural development in Alberta. It is the intention of the Provincial Government to "maintain the family farm, stimulate rural growth, and increase job opportunities through expansionistic agriculture policies, including the development of agriculture secondary and tertiary industry."[1]

The present concept of the processing of agricultural products is part of the technological change that has occured in the agricultural sector over the post-war period. The agricultural sector has become dominated by more efficient, and expensive equipment. As a result, relatively less labour has been employed (nearly 1.2 million people were employed in agriculture in 1946, this had declined by 61 percent to 467,000 in 1973). The small number of people engaged in agriculture have to diversify their farming operations, hedge against risk and uncertainty, and operate with increased efficiency.

The processing of agricultural products reduces uncertainty adds value to resources, and through a multiplier effect, adds jobs and incomes to communities. Alfalfa processing is an example of this theory in action. The various industrial assis-

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[1] Alberta Department of Agriculture, Analysis and Implications For the Development of The Alfalfa Processing Industry in Alberta, Agdex 121/843 (Edmonton: Alberta Agriculture, 1974), p. 1.

tance programs[1] available to alfalfa processors in Alberta are on the one hand, recognition of the confidence that Government has in this principle, and on the other, justification for evaluation of the performance of the industry.

Recent Expansion in Alfalfa Processing

Alfalfa is a crop commercially produced on a competitive basis in Alberta. The demand for this crop is increasing in both the domestic and international markets. However, to capture an extensive portion of this demand, there is a need to transform alfalfa from a bulky product to a more condensed form that is acceptable in market channels. This has been taking place recently through alfalfa processing, which reduces waste and creates a product which is cheaper to transport.

The alfalfa processing industry in the Province has achieved considerable growth in recent years. Since the end of 1973, when there were seven plants in operation, five new plants have been opened, bringing the total number to twelve at the end of 1975. The estimated production increased from 36,000 tons of dehydrated alfalfa in 1973 to 84,000 tons in 1975. Figure 1 shows the locations of the alfalfa processing plants in Alberta. With the exception of one plant at Vauxhall, which has been in operation for the last twelve years, the rest are less than seven years old.

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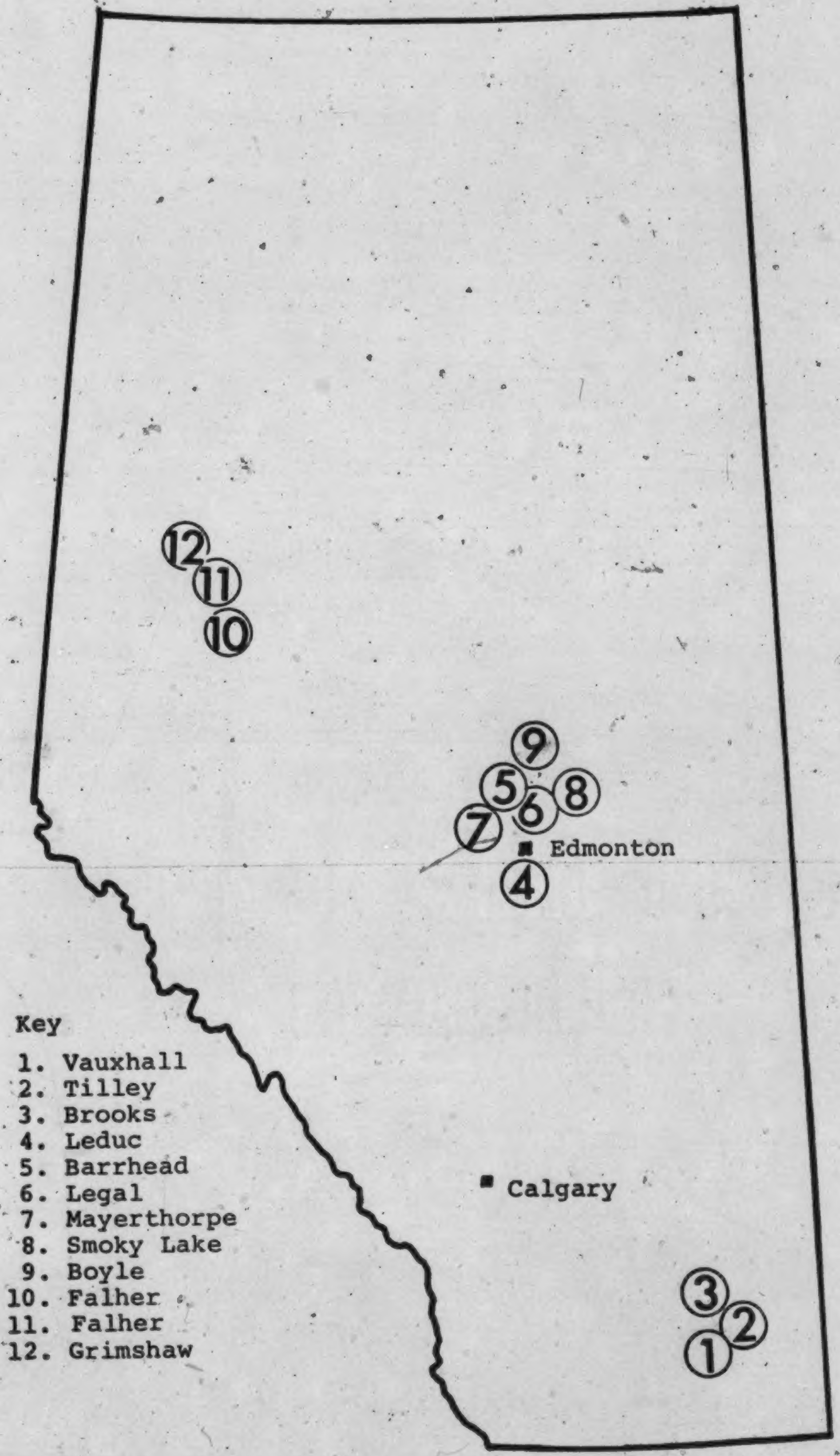
[1] The incentive loan which is granted through the Alberta Opportunity Company is one of the various industrial assistance programs. The loan is approved for a period of five years without interest and application may be made for forgiveness after that time.

Figure 1


12
11
10
9
5
8
6
7
Edmonton
4
Key
1. Vauxhall
2. Tilley
3. Brooks
4. Leduc
5. Barrhead
6. Legal
7. Mayerthorpe
8. Smoky Lake
9. Boyle
10. Falher
11. Falher
12. Grimshaw
Calgary
3
2
1

MAP OF ALBERTA SHOWING THE LOCATIONS OF ALFALFA PROCESSING PLANTS, 1975

The recent expansion was encouraged by the formation of the Alberta Alfalfa Processors Cooperative Association. In its articles of incorporation, one of the objectives of the association is to "promote the economic welfare of alfalfa dehydrating and processing firms throughout the province, by acting as agents for the procuring of supplies and services, and promoting such research as may be deemed necessary."[1]

Dehydrating plants in Alberta, depending on their locations, normally operate from June until the middle of October (about 120 days). Traditionally, the dehydrated alfalfa industry had consisted of small plants supplying local markets. Recently, the Economic Research and Analysis Branch, on behalf of the Department of Industry and Commerce, examined the possibility of expanding the dehydrating industry in Alberta by increasing the number and size of plants and developing export markets. It was hoped that the processing of alfalfa, being a relatively new activity in Alberta, would play an increasing role in the Alberta economy; hence, the justification for the expansion of the industry.

The Problem

One of the prime functions of alfalfa processing is to produce a diversified line of forage products. The products are to serve local, regional and foreign consumers. The Alberta

---

[1] Alberta Department of Agriculture, Analysis and Implications for the Development of The Alfalfa Processing Industry in Alberta, Agdex 121/843 (Edmonton: Alberta Agriculture, 1974), p. 1.

Department of Agriculture considers it important to investigate the competitive position of alfalfa relative to other crops in Alberta so that more informed decisions on production of dehydrated alfalfa can be made. The present study, which is based on the "Smoky Lake Alfalfa Processing Plant", forms part of the response to the investigation of the alfalfa industry.

The choice of the Smoky Lake Plant was at the discretion of the Alberta Department of Agriculture. The main reasons for the choice were that the plant is located in an important and high risk alfalfa growing area; the plant was experiencing several typical teething problems; and Smoky Lake Processors were among those who received the incentive loan through the Alberta Opportunity Company. The purpose of this study was to assess, from a financial and competitive impact perspective, the viability and the regional economic impact of the plant.

Therefore, the prime objectives of this thesis are:

(1) To examine the financial viability of the Smoky Lake Alfalfa Processing Plant.

(2) To examine the competitive impact of alfalfa production on the other farm enterprises.

(3) To examine the regional impact of the plant as a market outlet for local resource based production.

(4) To examine policy recommendations for the future of the plant.

CHAPTER II

ALFALFA INDUSTRY IN ALBERTA

Smoky Lake County

The town of Smoky Lake, the main center in the County of Smoky Lake, is 75 miles northeast of Edmonton on Highway 28. The alfalfa processing plant is located in the town. Figures 2 and 3 illustrate the main centres in Smoky Lake County and the location of the County, respectively.

Agriculture in Smoky Lake County is characterized by mixed farming and a broad base of salable commodities. According to the 1971 Census, there were 343 farms with sales of over $5,000 each. Another 178 farms had sales of $2,500 to $4,999; 353 farms had sales of less than $2,500. The livestock sector was comprised mainly of cattle and pigs. The total number of cattle was 25,271 while the number of pigs was slightly higher at 28,893. The value of farm capital amounted to $37.6 million. There were 890 trucks, 1,379 tractors, 522 combines and 390 bailers. The field crops consisted of barley, alfalfa and mixtures containing alfalfa, rapeseed, oats, wheat, mixed grains, flaxseed and rye. The most important crops were barley and alfalfa, accounting for 52.47 percent of the acreage devoted to field crops. Table 1 shows the acreage and the average percent distribution of field crops in the county.

The physical features of the county are known to be

TABLE 1

ACREAGE AND ACREAGE PERCENT DISTRIBUTION OF FIELD CROPS, SMOKY LAKE COUNTY, 1971

Crop	Acres	Percent Distribution
Barley	46,442	26.64
Alfalfa	45,030	25.83
Oats	28,570	16.38
Rapeseed	27,091	15.54
Wheat	19,189	11.00
Mixed Grains	7,813	4.48
Flaxseed	162	0.09
Rye	60	0.04
TOTAL	174,357	100.

Source: Statistics Canada, *Agriculture Alberta: 1971 Census of Canada*, Cat. 96-710. (Ottawa: SC, 1973).

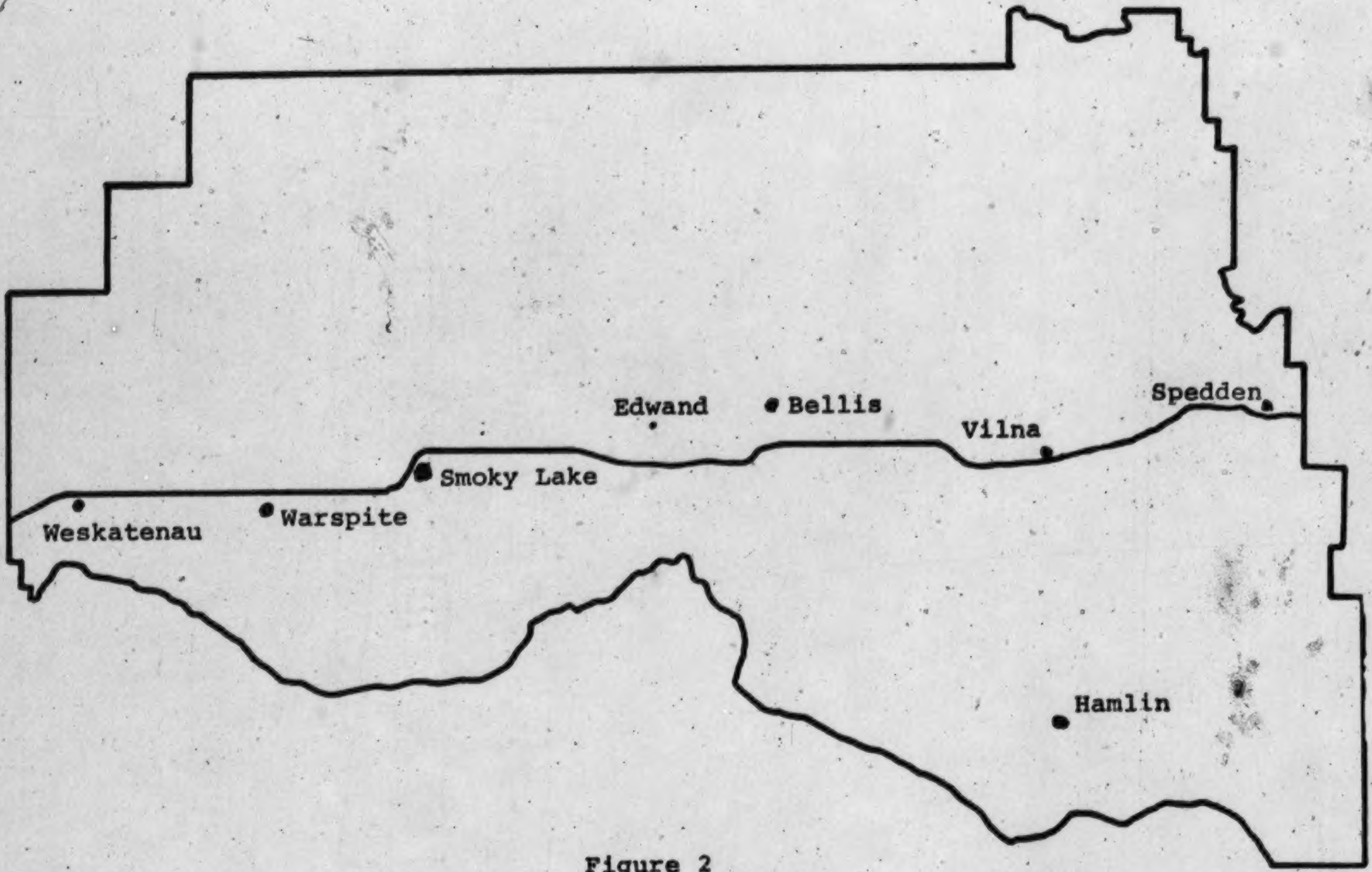
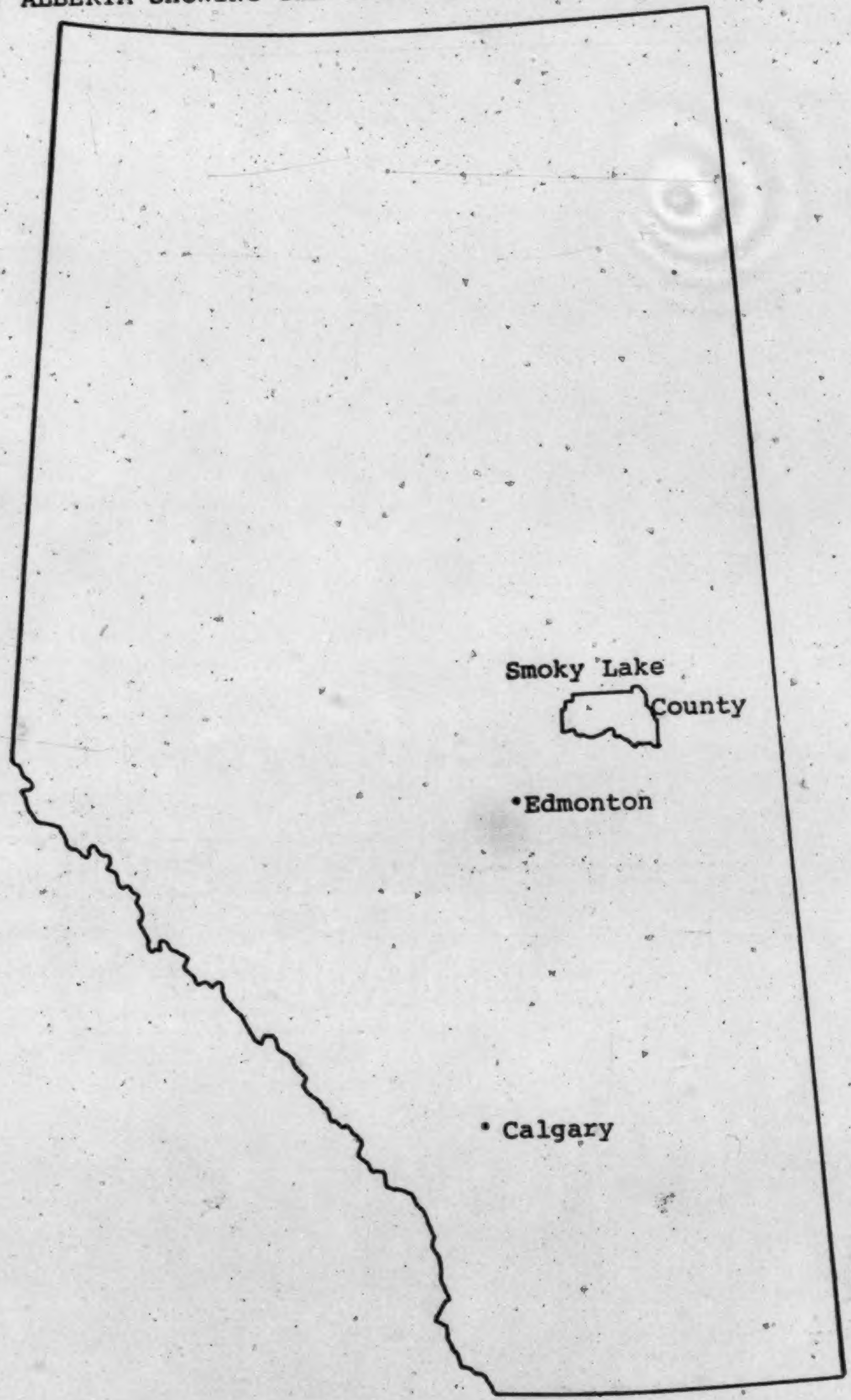

Spedden
Edwand
Bellis
Vilna
Smoky Lake
Warspite
Weskatenau
Hamlin

Figure 2

MAP OF SMOKY LAKE COUNTY SHOWING THE MAIN CENTERS

Figure 3

MAP OF ALBERTA SHOWING THE LOCATION OF SMOKY LAKE COUNTY


Smoky Lake
County
•Edmonton
• Calgary

suitable for alfalfa production. The soil group is generally gleyed dark grey and eluviated black. The dominant texture is loam, well drained and the topography is mainly undulating to gently rolling. The area is slightly stony. Moisture and climate conditions are limiting; for example, winter limits the growth and, therefore, harvesting activities, and as a result the alfalfa processing plant is idle for most of the winter months.

This forage crop is sown and grown by farmers who have contracts with the processing plant. The plant then undertakes to cut, haul, process, store and sell the product. The field operations involve the cutting of alfalfa at a specific stage of growth, deleafing and hauling it to the plant. The raw materials are analysed for protein, fibre and vitamin 'A' content, as required by the sales specifications.

The plant is centrally located within the alfalfa growing area. A choice of central location is dictated by the bulky and heavy nature of green alfalfa and the need to minimize the time lapse between cutting and processing. Distance of haul to the plant and management of the harvesting operations have serious cost and product quality implications. In general, plants try to acquire their alfalfa from within a five mile radius and tend to shy away from distances of ten miles of greater.

Alberta Perspective

Accurate statistics on the average and yields of alfalfa in this province are difficult to obtain. The bulk of the species is not grown in pure stands and is used for many purposes. However, according to the 1971 Census, there were 3.2 million acres devoted to perennial hay production in Alberta. Alfalfa or mixtures containing alfalfa accounted for 50 percent of the total hay production. The recent estimate is approximately 2 million acres of seeded alfalfa in Alberta. The Alberta Department of Agriculture has stated that:

> From a soil point of view, 80 percent of the cultivated land in the province can produce satisfactory stands of alfalfa without the addition of lime. Assuming that moisture and climate factors would limit profitable production on 30 percent of the agricultural regions, there would be left in the province roughly 50 percent of the cropland or 15 million acres well suited to grow alfalfa at least in rotation with other crops. Even a rotation requiring a very conservative 20 percent of the land in alfalfa, it is realistic to have a minimum 3 million acres readily available for alfalfa.[1]

Alberta's alfalfa production potential is good. According to published statistics on acreage devoted to alfalfa and alfalfa mixtures, Alberta has the highest acreage in Canada. Table 2 shows the acreage of alfalfa and mixtures containing alfalfa by province in descending order of importance.

---

[1] Ibid., p. 24.

TABLE 2

ACREAGE DEVOTED TO ALFALFA AND ALFALFA MIXTURES BY PROVINCE,* 1971

Province	Acres
Alberta	1,622,090
Ontario	1,521,866
Saskatchewan	1,040,197
Manitoba	679,396
Quebec	333,064
British Columbia	198,213

Source: Economic Research and Analysis Branch, "Alfalfa Dehydrating in Alberta" Edmonton: Industry and Commerce, 1973 (Mimeograph.)

* Data not available for Newfoundland, Nova Scotia, Prince Edward Island and New Brunswick.

Markets for Alfalfa Products

Several studies[1] have extensively covered the analysis of market outlets available for alfalfa products in this province. These previous studies analysed both the domestic and international markets. The domestic market was divided into two major outlets:

(1) purchases by commercial feed mills, and

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[1] Quintex Engineering Ltd., Boyle Forage Processors Ltd. Feasibility Study for a Forage Processing Enterprise, (Edmonton: Quintex Engineering Ltd., 1972); Department of Agriculture, op. cit.

(2) individual use for farm and feedlot.

The international market analysis was confined to examining the three main areas which at present appear to be significant in alfalfa trade:

(1) The West European trade,

(2) The U.S. market as a main supplier, and

(3) The Japanese market, which is the largest of all.

A consideration regarding both the domestic and international markets is that processed feeds are in direct competition with home grown feeds such as hay, alfalfa and grain. Unless the product has some specific attraction, the price of alfalfa products will be governed by the equivalent price of other commodities. Another consideration is that new products, as in the case of the alfalfa processing industry in Alberta, must break into the already established market. As such, sales strategy must be developed with strong emphasis on quality as the basis for competition.

The alfalfa nutrient analysis and the comparisons of alfalfa prices and the prices of other ingredients have been intended to convince prospective foreign buyers and the individual farmer of the advantages resulting from the use of alfalfa supplements compared with other feeds. Direct contact has been made usually with individual farmers and big domestic buyers such as feedlots and with foreign buyers. Table 3 shows purchases of legume and grass meal by flour and feed manufacturers in Alberta. Tables 4 and 5 give sales for domestic non-resale use and direct sales to consuming units for a number of alfalfa processing plants.

TABLE 3

PURCHASE OF LEGUME AND GRASS MEAL BY FLOUR AND FEED MANUFACTURERS IN ALBERTA, 1963-1971

Year	Dehydrated Alfalfa and Grass Meal		Sun Dried Alfalfa and Grass Meal	
	Quantity (Tons)	Value ($ '000)	Quantity (Tons)	Value ($ '000)
1963	7,332	376	3,308	195
1964	3,776	249	1,668	63
1965	3,630	220	1,139	48
1967	3,419	213	3,709	241
1968	5,396	320	7,691	357
1969	6,807	423	6,830	303
1970	7,226	412	9,841	372
1971	10,019	524	8,785	267

Source: Economic Research and Analysis Branch, "Alfalfa Dehydrating in Alberta" (Edmonton: Industry and Commerce, 1973). (Memeograph).

TABLE 4

SALES TO INDIVIDUAL USE ON FARM AND FEEDLOT, 1973

Alfalfa Pelleting Plants	Total Sales (tons)	Sales for Non-Resale (on farm) (tons)
Vauxhall	8,703	3,903
Tilley	12,000	1,200
Brooks	10,000	3,000
Leduc	8,000	800
Barrhead	2,500	2,500
Legal	10,000	3,300
Mayerthorpe	14,000	3,750
Smoky Lake	5,000	1,000
TOTAL	68,503	18,953

Source: Alberta Department of Agriculture, Analysis and Implications for the Development of the Alfalfa Processing Industry, Agdex 121/843 (Edmonton: Agriculture, 1974).

TABLE 5

DIRECT SALES TO CONSUMING UNITS, 1973

Alfalfa Cubing Facilities	Total Sales (tons)	Sales to Individual Use (on farm) (tons)
Vauxhall	23,000	17,000
Tilley	2,900	2,465
Brooks	500	500
TOTAL	26,400	19,965

Source: Alberta Department of Agriculture, Analysis and Implications for the Development of the Alfalfa Processing Industry, Agdex 121/843 (Edmonton: Agriculture, 1974).

The Western European Trade

The European Economic Community is another potential market for alfalfa products. This market is as yet insignificant but the trends show that consumption of alfalfa products may be expected to rise. Available statistics indicate that of the total consumption of 1.2 million tons of dried grass meal in 1971/72, less than 75,000 tons originated from outside the Common Market. However, the European countries have only recently entered into the processing era and it will take time before they achieve self-sufficiency in meeting their requirements of protein concentrates. As such, the EEC is not looked at as a potential supplier but a potential buyer. As the industry and the livestock sector get accustomed to the use of the product either as an input into prepared feeds or for direct feeding, the potential for export of Canadian alfalfa products to these countries becomes real. However, at this time the agricultural industry in the EEC is protected by tariffs against imports of non-member countries.

The Japanese Market

The largest market for alfalfa products from Alberta is Japan. Contacts to explore the Japanese market are made through Japanese representatives in Canada, feed brokers, and the Provincial and Federal Government agencies which organize missions to foreign countries. Tables 6 and 7 show the total imports of alfalfa meal and pellets to Japan and the countries of origin. U.S. leads all the countries in exporting alfalfa meal and pellets to Japan while Canada is the second largest exporter.

The U.S. Market

The U.S. Market is looked at as a supplier only. The U.S. is by far the largest producer and consumer of dehydrated alfalfa. The American alfalfa industry has developed over a long period of time, but a steady decline in production appears to have set in and, as such, U.S. will not meet the needs of the world market for alfalfa products. It is therefore hoped that Canada will obtain a bigger share of the market.

TABLE 6

JAPANESE IMPORTS OF ALFALFA MEAL AND PELLETS, 1966-1973

Year	Dehydrated Alfalfa (tons)	Suncured Alfalfa (tons)	Total (tons)
1966	179,570	165,757	345,327
1967	186,553	165,434	351,987
1968	185,620	164,607	350,227
1969	243,534	199,253	442,789
1970	308,533	223,420	531,953
1971	254,661	184,356	439,017
1972	224,190	162,345	386,535
1973	225,265	150,176	375,441

Source: Economic Research and Analysis Branch, "Background Information on Alfalfa Industry With Regard to Futures Market,(Edmonton: Industry and Commerce, 1973). (Mimeograph.)

CHAPTER III

CASH FLOW ANALYSIS

Concept of Cash Flow

One of the objectives of this thesis is to determine the financial viability of the Smoky Lake Alfalfa Processing Plant. Cash flow analysis provides a framework within which viability can be measured and judged. The use of a measure of cash flow emerges under at least seven different circumstances.[1]

1. In the literature of investments and security analysis.

2. In the statistics presented in the financial reviews and other similar sections of the annual reports of corporations.

3. As part of a title of a cash flow statement.

4. As the designation of the funds provided from operations in a funds statement.

5. In discussions of rate of return analysis, payback analysis in capital budgeting, and other similar managerial techniques where it is part of such expressions as "discounted cash flow."

6. With reference to cash projections of cash budgeting.

7. In the expression "Cash Flow" system, which refers to the control of cash in and out of a business in the pro-

---

[1] Perry Mason, Cash Flow Analysis and the Funds Statement. Accounting Research Study No. 2(New York:American Institute of CPA's, 1961), p.3.

motion of efficient creation and use of cash balances.

The concept of cash flow as the definition of the best measure of viability in project analysis is used by Little and Mirrlees.[1] For every year all expected expenditures on goods and services for the project and all expected receipts from the project are recorded. For each year, the subtraction of the former from the latter shows how much cash the firm gains or loses as a result of the project. Table 7 contains a detailed derivation of cash flow accounting.

The accounting technique contained in row 11 of Table 7 is only applicable to a new investment. "Borrowing and lending, and interest or dividend payments," according to Little and Mirrlees, "are normally excluded from the concept of cash flow when this is used for the purpose of assessing the profitability of a new investment."[2] Row 12 is the accounting technique relevant for assessing a project from the point of view of soceity. Alternatively, this technique is employed in economic analysis of investment projects for public benefits.

In economic analysis of investment projects for public benefits, income taxes, sales taxes and custom duties are transfer payments within the society, not payments for resources used in production. They are not deducted from the stream of benefits when deriving the cash flow, which is the basis on which the productivity of capital will be computed. For the purpose of this study, the accounting technique contained in row 9 is applied to assessing the financial viability of Smoky Lake plant. The plant is privately owned and therefore taxes are a cost which the individual entity must pay before arriving at the amount available for recovering its capital and compensating it for the use of its capital.

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[1] Ian M.D. Little and James A. Mirrlees, Manual of Industrial Project Analysis in Developing Countries: Vol. II. Paris: Development Centre of the Organization for Economic Cooperation and Development, 1968.

[2] Ibid., p. 18.

There is another difference between assessing profitability of public investment as opposed to the private. The analysis for private investment treats borrowed capital as it is received into the receipt streams as a kind of benefit received. When payments of interest or repayment of principle is made to the outside supplier of capital, it is deducted from the gross return as a cost in deriving the cash flow. The same treatment of borrowing can only be applied to the economic analysis of the public investment when foreign capital is involved because of the assumption that all resources employed in the project belong to someone within the society. Therefore, borrowing does not enter into economic analysis of public projects when there is no foreign capital involved.

The assessment of a project from the point of view of society is recognised by Gittinger in his definition of cash flow. According to Gittinger:[1] "When we look at a project we can see it as earning a stream of gross benefits from which

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[1] Gittinger, J. Price. Economic Analysis of Agricultural Projects. (London: The Jones Hopkins University Press, 1972), p. 66.

TABLE 7

CASH FLOW ACCOUNTING

1.	Current Sales (net of indirect taxes)	R
2.	Payment for Current Inputs (including wages and salaries)	C
3.	Interest Charges	I
4.	Direct Taxes	T
5.	Current Cash Flow	R-C-I-T
6.	Less Net Capital Expenditures	K
7.	Total Cash Flow (excluding borrowing and lending)	R-C-I-T-K
8.	Add Net New Borrowing	B
9.	Total Cash Flow	B+R-C-I-T-K
10.	Less Cash Flow Arising from Financial Transactions	B-I
11.	Cash Flow from Non-Financial Transactions.	R-C-T-K
	Add Back Direct Taxes	T
	Add Indirect Taxes on Inputs	T*
12.	Social Cash Flow	R-C-K+T*

we must deduct the capital investment and pay the other input costs -- the machinery, fertilizer, pesticides, labour, management-consultants, etc. What is left over is a residual that is available to recover the investment made in the project (the return of capital), and compensate for the purpose of the money involved in the project (the return to capital or on capital)." This residual is termed cash flow.

The major common characteristic of all cash flow concepts is that they include undifferentiated return of capital and return to capital. Therefore, to compute the cash flow, no allowance for depreciation is deducted from the gross returns.

Depreciation

In accounting, depreciation is defined as the allocation of the cost (purchase price minus salvage) or an asset which will be used up over a long period of time by charging a portion of the cost to each period of expected life. But to compute the cash flow, deduction from the gross return of any allowance for depreciation, that is, return of capital, is not done because the analytical technique will take care of the return of capital in determining the value of the project. In the same way, when determining the gross cost stream for calculating discounted measures of the project value, depreciation is not included as a cost (that is, return to capital) in spite of the fact that internal rate of return is a measure of the capacity (return to capital), while net present value determines if the project can earn more than some stated amount of return to capital. However, the return to capital is realised (depreciation is covered and fully accounted for) when the project earns an internal rate of return of zero or greater, when the net present value at zero discount rate is zero or greater, or when the benefit cost ratio is one at a zero or greater rate of interest.

Discounted Cash Flow

Cash flow projections applied to investment viability issues such as the Smoky Lake alfalfa plant are generally discounted. Discounting is common practice because a dollar in hand today is believed to be more valuable than a dollar to be received in the future. Therefore, future cash flows cannot be aggregated with equal weights. For the purpose of aggregration, a rate of discount must be selected. This is a rate of return which, given the financial conditions for obtaining cash and the investment opportunities likely to be open to the firm in future years, is considered necessary to earn on the new investment.

The process of discounting is compound interest worked backwards. Expenditures and receipts which occur at different times are all revalued to make them comparable to present expenditures and receipts. They can be added up to give a single figure, the "present value". It comes to the same thing to substract expenditures from receipts to give a cash flow for each year and then discount the cash flows back to the present. In general, the formula applied to discount the future cash flows back to the present is given by:

$$PV = \frac{FV}{(1+i)n}$$

where: PV = present value,

FV = future value,

i = interest rate,

n = number of years.

Choosing the Discount Rate

According to Gittinger, for the purpose of analysing public projects:

> The most appropriate rate is the opportunity cost of capital-- that rate which will just result in all the capital in the economy being invested if all possible projects were undertaken which yielded that much or more return. If set perfectly, the rate would just reflect the choice made by society as a whole between present and future returns, and hence, the amount of total income the society is willing to save.[1]

In the case of private investment, the most appropriate rate is that rate which is more or less close to the rate at which the firm can borrow, usually, the market rate of interest. In common practice, for both public and private projects, there are problems associated with establishing this rate.

It is suggested that the discount attached to future returns by the society as a whole is different from that which individuals use. It is felt that society has a longer time horizon so its discount rate is lower. This implies differing rates of interest for public and for private projects. But, according to Nichols, "there is little agreement among economists on how that rate should be chosen."[1] In practice, the rate chosen is simply a rule of thumb although most countries believe it is between 8 and 15 percent.

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[1] Ibid., p. 90.

Alternative Measures of Viability

The use of a measure of cash flow emerges under various methods. The most commonly used are the benefit/cost ratio and the internal rate of return.

Benefit/cost ratio is a ratio of benefit to cost in which estimates of benefits and costs of a project accruing at various times are made comparable through adjustment to a uniform basis using a discount or interest rate. The estimation of costs and benefits involves the listing and consideration of as many effects as can be identified and all persons and groups likely to be affected, however remotely, by a project. For the purpose of determining the financial viability of the Smoky Lake alfalfa plant, the benefit/cost ratio technique is not applied because, according to Gittinger: "The benefit/cost ratio is used almost exlusively as a measure of social benefit, and most commonly for water resource projects. It is almost never used for private investment."[2] However, when the benefit/

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[1] D.A. Nichols, "The Public Discount Rate". Madison: University of Wisconsin, June 1974, p. 1 (Mimeograph).

[2] J. Price Gittinger, op. cit., p. 60.

cost ratio is used, the project should have a ratio of one or greater to be justified.

The internal rate of return is defined as the rate of discount which makes the present value of the project zero. The value represents the average earning power of the money used in the project over the project life. The earning power is important because entrepreneurs and other investors are more used to judging investments by their yield rather than by either of the other measures. Because of the general acceptance of the internal rate of return, this measure has been applied to the Smoky Lake alfalfa plant.

The formal selection criterion for the internal rate of return measure of a project value is to accept all projects having an internal rate of return above the opportunity cost of capital. One cannot randomly select that discount rate which will make the cash flow equal to zero. There is no formula for finding the rate of return, therefore one must resort to trial and error.

The trial and error method begins with a discount rate which a quick quess indicates might be in the right neighborhood. Then, by interpolation one can estimate the true value. Interpolation is finding the intermediate value between the two discount rates (lower discount rate and higher discount rate). The rule for interpolating the value of the internal rate of return which lies between discount rates too high on one side and too low on the other is given below:

$$\text{Internal Rate of Return} = \text{Lower Discount Rate} + \text{Difference Between the Discount} \left[\frac{\text{Present Value of Cash Flow at the Lower Discount Rate.}}{\text{Absolute Difference Between the Present Value of the Cash Flow at the Two Discount Rates.}} \right]$$

Limitations of Cash Flow Concepts

The cash flow accounting concept differs from normal accounting terminology because cash flow accounting excludes depreciation. As such, the use of cash flow accounting is controversial and has not been completely accepted by accountants. For example, Perry Mason, writing a critique of cash flow analysis,states that:

> The concept of cash flow as the amount of funds derived from operations (net income plus depreciation, etc.) can serve as an effective analytical tool. The discussion, presentation and interpretation of cash flow data is, however, often inadequate and sometimes inaccurate and misleading.[1]

In accounting terminology, depreciation is a cost because a depreciable asset uses funds in the period in which the acquisition takes place. This cost must be covered during the scope of the depreciable asset's life by the excess of revenue over operating costs other than depreciation on that asset if a loss from operations is to be avoided. In other words, depreciation is an operating cost or expense and the purpose of depreciation accounting is to distribute the cost systematically over the operating periods included in the useful life of the real assets. On the other hand, it is argued that the annual charges for depreciation and amortization are merely bookkeeping entries and do not represent corresponding outlays of cash. As such, management has considerable discretion in setting aside actual annual amounts of money in the name of depreciation.

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[1] Perry Mason, Op. cit., p. 30.

Cash Flow Projections

In evaluating a potential investment, one is basically concerned with quantifying the stream of future benefits and costs accruing over a finite planning period. Because future benefits and costs are liable to change over time for exogenous reasons, the eventual outcome may be quite different from the outcome originally anticipated. Some of these exogenous reasons include risk and uncertainty, and in most cases, inflation. It is suggested that the only realistic assessment of the future is that inflation will continue. The problem therefore becomes one of how to cope with inflation in making realistic projections such as those required for the Smoky Lake alfalfa plant.

There are several approaches to projections that can be utilized to cope with inflation. Although none of them serve as a panacea, it is the function of a science to make predictions and any procedure that can help in making a better guess concerning the future is of practical importance. Below are some of the approaches that can be applied to determine future prices and costs:

(1) Inflate all costs annually by what you think will be an average rate of inflation.

(2) Assume that all prices on both the outflow side and the inflow side will rise uniformly by the same proportion and that they will therefore not change their relative values.

(3) Assume constant prices for all items except the ones you think will be affected disproportionately by inflation. Prices for the latter group of items are increased or decreased to reflect relative changes in prices arising from the differing impact of inflation.

For the purpose of cash flows projection of the Smoky Lake alfalfa plant, the latter method was adapted. It is believed that the impact of inflation on items such as labour costs and fuel is significantly more noticeable than that on items such as licence and property tax.

Data

The data used for the projections were obtained from Smoky Lake Alfalfa Processors Ltd. Financial Statements[1] for the years of 1972, 1973, 1974 and 1975. The main parts of these financial statements were:

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[1] Clarkson, Gordon and Co., Chartered Accountants, "Smoky Lake Processors Ltd. Financial Statements, March 31, 1972, 1973, 1974 and 1975." (Mimeographed.)

(i) the statement of income,

(ii) the statements of deficit; and

(iii) changes in financial position for the year then ending.

For the purpose of cash flow projections, the above statements were not suitable. They were rearranged to achieve consistency. Fixed costs were separated from variable costs. In economics, usually a distinction is made between fixed and variable costs. Fixed costs are those costs of a business which go on regardless of the amount of production while variable costs are those expenses of a business or industry that vary with the amount of business done or the volume of goods processed. The equivalent of fixed costs, as presented in the financial statements, were the administrative costs. The cost of goods processed corresponded to the variable costs. However, the cost of goods processed contained several items such as licences, utilities and spur-line rental which did not vary with the volume of goods processed. These more or less fixed costs were therefore classified with the administrative costs for purposes of the cash flow analysis. All these fixed costs, with the exception of the management salaries, were assumed constant while the variable costs were increased to reflect changes in prices.

Fixed Costs Projections

A list of items for which future prices have been assumed constant is contained in Table 8.[1] The cost of each item is given for the four years 1972-1975. For the purpose of cash flow projections, those costs which occurred in 1975 provided the projection base; 1975 was chosen because the plant has only recently been established. This projection base also applied to variable costs projections. The range in these fixed costs is such that an average of four years is evidently distorted. After a period of four years of plant operation, it is believed that almost true cost values have been established.

In order that the assumption of constant prices be strengthened, each item has been documented. The following is how each item has been handled.

1. Licence fees: This item is a fixed cost to the plant, payable once a year. The cost of licencing plant operations has remained almost unchanged since the beginning of operations four years ago. This trend is assumed to hold so that no significant change can affect the cash flow.

2. Telephone charges: An increase in telephone rates was announced recently by the Public Utilities Board. However, the Board asserts that this increase cannot be relied upon as a 'forecast indicator' because the past rates have not been

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[1] The only exception is management salaries.

TABLE 8

THE FIXED COSTS: SMOKY LAKE ALFALFA PROCESSORS LTD., 1972-1975

Item	1972 $	1973 $	1974 $	1975 $
Licence	537	368	417	417
Telephone	155	868	1022	754
Advertising	1414	55	22	154
Professional Services	1000	3830	7877	3395
Travel	244	364	915	1432
Office Expenses	823	486	225	581
Utilities	774	1336	1232	2148
Spur-Line Rentals	679	924	930	930
Management Salaries	6600	9900	13200	17250
Insurance	2713	3902	4201	4457
Property Tax	1874	7506	8837	8749
Other	87	501	556	556
TOTAL	16900	30040	39434	40823

Source: Clarkson, Gordon and Co., Chartered Accountants, "Smoky Lake Processors Ltd. Financial Statements, March 31, 1972, 1973, 1974 and 1975." (Mimeographed).

characterised by any significant changes.[1] Therefore, in this analysis, the cost of telephone is held constant partly because of this historical trend and partly because any possible increases, given the small size of the plant, would have no significant effect on cash flow.

3. Advertising costs: Advertising, as practised by the management body of any alfalfa enterprise in this province, is aimed at providing information, especially to cattle feeders. The Management Body of Smoky Lake Alfalfa Processing Plant are not thinking about any drastic changes that might alter this policy. Because of this intent, there are no added advertising costs expected. Therefore, the current cost is assumed constant in this analysis.

4. Travel costs: These costs may not be avoided at certain times. The manager is expected to attend meetings, conferences or seminars which concern the alfalfa enterprise. Such travels, however, are mainly within the Province of Alberta and are therefore not costly. The cost of travel up to the present has ranked as one of the smallest expenditures since the plant went into operation. It would therefore seem safe to assume a constant cost in the analysis.

5. Office expenses: These include the purchase of office equipment, stationary and general office supplies. Most of the equipment was bought at the beginning of operation. The nature of the business is such that it does not require

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[1] Interview with R. Atkinson, Economist, Public Utilities Board, Edmonton, Jan. 15, 1976.

expensive office equipment. The expected future costs will arise out of the need to replace equipment that is broken or lost. As such, the expenditure on this equipment is not expected to constitute any sizeable amount that might erode the financial standing of the enterprise.

6. Utilities: Utilities consist of water supply and electricity. The Public Utilities Board asserts that the historical trend has not shown increases beyond the average rate of inflation. This trend is assumed to hold, so that the cost of utilities is projected without disproportionate changes in cost.

7. Spur-line rental: The cost of renting the spur-line has remained fixed since the plant started operating. The present facilities provided by the spur-line are capable of handling full capacity production of the plant. As such, there is no need to rent a second spur-line and, therefore, no additional costs are incorporated in the projection.

8. Management salaries: Management salaries do not depend on the volume of output. Nevertheless, management salaries are expected to increase at a rate beyond the rate of inflation. A percentage increase of 5.4 percent[1] has been assumed in determining the annual increase expected by the management body.

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[1] According to Statistics Canada, the price index for wages was 105.4 percent in March 1975 over that of March 1974, taking the latter period as the base at 100 percent. Statistics, Canada, Prices and Price Indexes, Cat. No. 62-002. (Ottawa: SC, 1975). The 5.4% is not related to productivity (Productivity is assumed constant). Management is expected to maintain its labour force more or less at the same level.

9. Insurance: Insurance costs have increased about 40 percent since the Smoky Lake plant went into operation (1972). This increase, according to the Treasurer of the enterprise, is attributed to the increase in field equipment (harvesters, trucks,etc.) acquired over the period. The required number for full capacity production has been obtained. Future additions to equipment are expected to be limited to replacements, and so insurance coverage should remain constant.

Insurance premiums, while vulnerable to radical change as evidenced by recent hikes, are expected on average to remain within average inflation levels. According to Mr. Cooper[1] of the Insurance Bureau of Canada, the recent premium increases are not a good forecast indicator. The past ten years have been characterised by negligible changes in rates.

10. Property tax: The bases on which taxes are levied are:

(a) a percentage of the assessed value of real property,

(b) the assessed annual rental of immovables and the area of premises occupied for business purposes, and

(c) the value of stock-in-trade.

On these bases, property tax levied on the Smoky Lake Alfalfa Processing Plant is expected to remain stable. The nature of the business is not going to be changed and mill rates are constrained by voter acceptance. The property tax paid in 1975 was actually less than that of 1974.

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[1] Personal Interview with R.A.S. Cooper, Alberta Manager, Insurance Bureau of Canada, Edmonton, Jan. 15, 1976.

Variable Costs Projections

An explanation as to how the projection base was arrived at has already been given.[1] As already stated, it is assumed that variable costs will be affected disproportionately by inflation and will vary with the volume of goods processed. These two considerations provided the basis on which to calculate the future variable costs. A list of variable costs since 1972 for the Smoky Lake plant is given in Table 9 and Table 10 shows throughput coefficients applied to those variable items in terms of cost per ton processed. These coefficients are averages of the past four years. Each variable cost has been documented and treated separately.

1. Cost of raw material: The cost of raw material will increase as the plant approaches full capacity, and will level off thereafter. Raw materials are based on a technicial transformation rate of three tons of fresh cut forage to one ton of pellets. A ton of wet forage is valued at $25.[2] A 75 percent full capacity output of 12,000 tons of alfalfa pellets requires 36,000 tons of raw alfalfa at a cost of $900,000.

2. Wages and benefits: The wages and benefits will increase with output and will be affected disproportionately

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[1] Refer to section on fixed costs projections.

[2] The price paid for wet alfalfa fluctuates year by year depending on the availability. But for the last three years (1973-1975) the price has not exceeded $22 per ton. The assumed price of $25 per ton is expected to accommodate future increases in price.

TABLE 9

variABLE COSTS: SMOKY LAKE ALFALFA PROCESSING PLANT, 1972-1975

Item	1972 $	1973 $	1974 $	1975 $
Raw Material	42,310	69,898	95,053	112,126
Wages and Benefits	28,076	59,162	66,432	95,432
Freight and Handling	21,597	55,346	41,461	2,560
Natural Gas	5,664	18,475	18,387	16,897
Rapeseed Oil	1,842	4,040	10,556	5,235
Fuel	6,773	8,883	9,702	18,765
Equipment Repairs	6,110	17,310	41,786	50,608
Field Equipment Rental	1,483	1,655	9,524	12,802
Bad Debt Expenses	602	603	400	400
TOTAL	114,457	235,372	293,301	314,625

Source: Clarkson, Gordon and Co., Chartered Accountants, "Smoky Lake Processors Ltd. Financial Statements, March 31, 1972, 1973, 1974 and 1975." (Mimeographed).

TABLE 10

THE THROUGHPUT COEFFICIENTS (AVERAGES) IN TERMS OF COST PER TON PROCESSED: SMOKY LAKE ALFALFA PROCESSING PLANT, 1972-1975

Item	Cost per Ton Processed ($)
Raw Material	13.50
Wages and Benefits	10.40
Freight and Handling	4.16
Natural Gas	2.36
Rapeseed Oil	1.36
Fuel	1.93
Equipment Repairs	4.61
Field Equipment Rentals	1.06
Bad Debt Expenses	0.18

Source: Computed from Clarkson, Gordon and Co., the Smoky Lake Alfalfa Processors' Financial Statements for the year ending 1972, 1973, 1974 and 1975.

by inflation. Both considerations are incorporated in the cash flow projections. The percentage increase of 5.4 percent per year is used to inflate the technical labour value input/output coefficient of $10.40 per ton of pellets. The projected labour costs will be subject to the allowance for disproportionate wage inflation and assumptions about the level of production.

3. Freight charges: The cost of freight and handling is a function of the level of processing. When the projected capacity is achieved, the cost of freight and handling is not expected to change significantly. Therefore, the throughput coefficient in terms of cost per ton processed, that is, $4.16, is applied in the analysis.

4. Natural gas: The cost of natural gas is expected to increase with output as well as because of market price changes. The throughput average cost coefficient per ton for 1972-1975 was $2.36. When the projected capacity is reached, the only factor taken into account will be that for disproportionate natural gas price inflation.

5. Cost of rapeseed oil: The amount of rapeseed oil required will depend on the level of processing, but the cost of rapeseed is not expected to increase at a rate beyond the rate of inflation. "There is a great likelihood," according to Gittinger, "that the relative price of agricultural products will remain as much as it has been in the past. Only when there is a clear-cut case for changing the relative prices would it

seem justified to abandon the assumption that relative prices of agricultural products will remain the same."[1] Therefore, the projected cost of rapeseed will be subject to the assumption about the level of production and when the plant approaches full capacity, the cost of rapeseed oil will not be significantly affected by the rate of inflation.

6. Cost of equipment repairs: The amount of increase in equipment will depend on the level of business. But since the required number for full capacity production has already been obtained, the cost of equipment would be expected to remain fairly constant. However, repair work involves the use of labour. Because labour costs compose a high proportion of repair costs, the cost of repairs is expected to be affected disproportionately by inflation. The projected repair costs are based on the average throughput coefficient of $4.61 adjusted by an allowance for disproportionate wage inflation.

7. Cost of field equipment rentals: Field equipment consists of harvesters and trucks. The plant rents field equipment in addition to what it owns. In most cases, an increase in purchases of green alfalfa makes it necessary for Smoky Lake alfalfa processors to rent field equipment to supplement their own. Therefore the cost of field equipment will increase as the plant approaches full capacity, and will level off thereafter. The average throughput cost coefficient was $1.06 per ton from

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[1] J. Price Gittinger, op. cit., p. 35.

1972-1975. The future cost increase of equipment rental is expected to be limited to this coefficient.

8. Bad debt expenses: It seems reasonable to assume that increased output will lead to more financial transactions. Good financial management should keep bad debts to a minimum and records so far show little problem with bad debts. However, bad debts are also due to the number of transactions. Therefore, the cost to the plant of these bad debts is expected to increase with the volume of output; when the projected capacity is achieved, the cost of bad debts is expected to remain constant.

Current Inflows

The current inflows for the Smoky Lake plant are classified under two categories:

a) the amount of pellets sold; and

b) the value of inventory.

Table 11 shows the actual current inflows for the period 1972 to 1975 inclusive. The approach taken to project these current inflows is documented below:

1. The amount of pellets sold: The annual throughput of the Smoky Lake Alfalfa Processing Plant has ranged between 3,335 tons and 7,734 tons of pellets since the plant started production in 1972. Most alfalfa plants with the same capacity (16,000 tons) in this province have been able to produce 12,000 tons in their second year of operation. An example is provided

by the Falher Alfalfa Company Ltd., where two shifts per day with a throughput of 80 tons per shift have been achieved by the second year of operation. Given 100 days of operation annually and 160 tons per day, the current annual throughput of the Falher plant amounts to 16,000 tons. It is therefore possible that the same amount could be achieved by Smoky Lake alfalfa processors; however, the first four years of operation cannot make one optimistic about achieving a throughput of 16,000 tons. Therefore, the most likely projection of revenue, given the price, is based on the assumption that only 75 percent of capacity will be utilised.

The price per ton of pellets was $55 in 1973. In 1974 there was a considerable increase when the price per ton went to $70. Another increase in price to $85 was experienced in 1975. The market situation has therefore been favourable; but, it is asserted that there was a shortage of animal protein, especially in 1974. Since, then, the situation is believed to have improved and for the purpose of revenue projection in this study, the most likely price is assumed to be $70 per ton.

TABLE 11

CURRENT INFLOWS: SMOKY LAKE ALFALFA PROCESSING PLANT, 1972-1975

Item	1972	1973	1974	1975
Pellets Sold	82,245	290,405	507,668	323,017
Value of Inventory	24,929	63,581	59,862	166,770
TOTAL	107,174	353,986	567,530	166,770

Source: Clarkson,Gordon and Co., Chartered Accountants, "Smoky Lake Processors Ltd. Financial Statements. March 31, 1972, 1973, 1974 and 1975." (Mimeographed.)

2. Value of inventory: The value of inventory is that of unsold output. This output is held in the normal inventory and is ready for sale. It is therefore treated as a current revenue in the year it is produced rather than in the year it is sold. For the purpose of projecting the value of inventory, it is assumed that 1,000 tons, valued at $70,000 will be maintained.

Capital Outflows

Capital outflows represent the amount spent on capital goods such as buildings and storage. In common practice, capital outflows occur at the beginning of the investment. Table 12 shows that most of these outflows took place in the first year of plant records.

TABLE 12

CAPITAL OUTFLOWS: SMOKY LAKE ALFALFA PROCESSING PLANT, 1972-1975

Item	1972 $	1973 $	1974 $	1 75 $
Plant and Field Equipment	281,673	6,537	-	110,835
Buildings and Storage	224,995	-	47,086	-
Plant Site	46,871	-	-	-
Development Costs	48,685	1,705	-	-
Power Generators	70,462	-	-	-
TOTAL	672,688	8,242	47,086	110,835

Source: Clarkson and Gordon and Co., "Smoky Lake Alfalfa Processors Financial Records, March 31, 1972, 1973, 1974 and 1975." (Mimeographed.)

In the cash flows projections, outflows were related to capital items that have a short span of life. The expected life of buildings is twenty years while the assumed life of field equipment and power generators is five years and ten years, respectively. Therefore, in projecting capital outflow, some amount of money has been phased at intervals of five years for field equipment and ten years for power generators. This treatment is not extended for buildings with a life span of twenty years since the planning period covers fifteen years.

Capital Inflows

Capital financing was obtained through borrowing and from share equity capital. Borrowing consisted of one long term loan of $400,000 and an incentive loan of $135,000. The company is not expected to pay either interest or repayment on principle for the incentive loan.

The long term loan from Alberta Opportunity Company was approved in 1972, but since construction and equipment were made in 1971, the company was authorized to borrow short term monies from commercial banks. These loans were paid off when the long term loan arrangements were completed in 1972. As such, the cash flow analysis includes only the amount of the long term loan. But, the bank charges on the interim borrowings are included since they were real cash outflows.

Since the long term loan for the plant was approved, the processors have continued to borrow short term monies, It

TABLE 13

PROJECTED LOAN PAYMENT SCHEDULE ON LONG-TERM LOAN AND INTEREST CHARGES ON SHORT BORROWINGS: SMOKY LAKE ALFALFA PROCESSING PLANT (1972-1987)

Year	Balance on Principal (Long Term Loan)	Interest	Principal Portion	Interest on Short Borrowings	Total Amount Paid
1972	396,469	7,847	3,531	18,069	29,447
1973	381,632	30,674	14,837	31,164	76,675
1974	365,544	29,464	16,088	31,222	76,774
1975	348,190	28,153	17,354	36,964	82,471
1976	329,416	26,737	18,774	36,964	82,475
1977	309,110	25,205	20,306	36,964	82,475
1978	287,147	23,548	21,963	36,964	82,475
1979	263,392	21,756	23,755	36,964	82,475
1890	237,698	19,187	25,694	36,964	81,845
1981	209,908	17,721	27,790	36,964	82,475
1982	179,850	15,453	30,058	-	45,511
1983	147,339	13,000	32,511	-	45,511
1984	112,176	10,348	35,163	-	45,511
1985	74,143	7,475	38,033	-	45,511
1986	33,007	4,375	41,136	-	45,511
1987	-	1,093	33,007	-	34,100

has been considered realistic that this trend could continue. However, for the purpose of this study the trend is assumed to end in 1981 and the phasing of interest on short term loans covers the period from 1972-1981.

On the long term loan, a rate of interest of 8 percent plus repayment of principle are paid annually. The arrangement made with the Alberta Opportunity Company is that the loan must be fully paid for by 1987. The phasing of interest and repayment of principal is extended to that year. The projected loan repayment schedule is contained in Table 13.

Sensitivity Analysis

One of the real advantages of careful economic analysis for either public investment or private investment, is a test of what may happen to earning capacity if something goes wrong. For the purpose of this analysis several assumptions with respect to varying both capacity and price were applied to gain an insight into what would happen if the pellet price was lower or higher than the $70 projected. In the same way, the actual throughput percentage of capacity could be less or more than the 75 percent projected. The following assumptions were applied to determine the sensitivity of the plant's financial viability to different circumstances.

1. The price per ton of pellets was set at $50 and was then applied to throughput of 40 percent, 60 percent, 75 percent and 95 percent capacities.

2. The price of $70 per ton of pellets used to derive the most likely current cash inflows at 75 percent of capacity in the cash flows projections was applied to throughput of 40 percent, 60 percent and 95 percent capacities.

3. The price per ton of pellets sold was increased to $100. This price was then applied to the throughput percentages already cited.

A shortcut procedure for the necessary computations was followed. The 75 percent throughput capacity used for the most likely cash flows projections provided a base to compute changes in variable costs according to the capacity levels of 40 percent, 60 percent and 95 percent. The fixed charges were not altered.

Results of Cash Flow Projections

The results for the most likely cash flows projections for Smoky Lake plant are contained in Table 14. The annual totals are summarized in Table 15. Over the projected period, total inflows are more than total outflows by $2,448,031. The discounted cash flows for each year are contained in Table 16. The discounting rates vary from 5 percent to 16 percent.

A positive net present value holds at the discounting rate of 5 percent and at the subsequent rates of interest up to 15 percent. At a discount rate of 16 percent, the net present value is negative (-$33,166), but at a rate of 15 percent, the net present value is greater than zero at $6,431. Table 17

TABLE 14

Cash Flows Projections For The Smoky Lake Processing Plant, 1972-1990.

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	Total
Current Outflows																				
i) Fixed Cost																				
Licence	537	368	417	417	417	417	417	417	417	417	417	417	417	417	417	417	417	417	417	7,994
Telephone	195	868	1,022	754	754	754	754	754	754	754	754	754	754	754	754	754	754	754	754	14,109
Advertising	1,414	55	22	154	154	154	154	154	154	154	154	154	154	154	154	154	154	154	154	3,955
Professional services	1,000	3,830	7,877	3,395	3,395	3,395	3,395	3,395	3,395	3,395	3,395	3,395	3,395	3,395	3,395	3,395	3,395	3,395	3,395	67,027
Travel	244	364	915	1,432	1,432	1,432	1,432	1,432	1,432	1,432	1,432	1,432	1,432	1,432	1,432	1,432	1,432	1,432	1,432	24,435
Office expenses	823	486	225	501	501	501	501	501	501	501	501	501	501	501	501	501	501	501	501	10,839
Utilities	774	1,336	1,237	2,148	2,148	2,148	2,148	2,148	2,148	2,148	2,148	2,148	2,148	2,148	2,148	2,148	2,148	2,148	2,148	37,710
Spurline rentals	679	924	930	930	930	930	930	930	930	930	930	930	930	930	930	930	930	930	930	18,413
Management salaries	6,600	9,900	13,200	17,250	18,181	19,163	20,198	21,289	22,439	23,651	24,928	26,274	27,693	29,188	30,764	32,425	34,176	36,021	37,966	451,306
Insurance	2,313	3,902	4,201	4,457	4,457	4,457	4,457	4,457	4,457	4,457	4,457	4,457	4,457	4,457	4,457	4,457	4,457	4,457	4,457	82,128
Property tax	1,874	7,506	8,037	8,749	8,749	8,749	8,749	8,749	8,749	8,749	8,749	8,749	8,749	8,749	8,749	8,749	8,749	8,749	8,749	158,201
Other	87	501	556	556	556	556	556	556	556	556	556	556	556	556	556	556	556	556	556	10,040
Sub-Total	16,900	30,040	39,434	40,873	41,754	42,736	43,771	44,862	46,012	47,224	48,501	49,847	51,866	52,761	54,337	55,998	57,749	59,594	61,539	885,148
ii) Variable Costs																				
Purchase of raw material	42,310	69,868	95,053	112,126	162,000	162,000	162,000	162,000	162,000	162,000	162,000	162,000	162,000	162,000	162,000	162,000	162,000	162,000	162,000	2,749,387
Wages and benefits	28,076	59,162	66,432	95,432	124,000	131,539	138,116	145,022	152,273	159,887	167,881	176,275	185,889	195,183	204,942	215,109	225,948	237,245	249,107	2,950,198
Freight and handling	21,597	55,346	41,461	2,560	49,920	49,920	49,920	49,920	49,920	49,920	49,920	49,920	49,920	49,920	49,920	49,920	49,920	49,920	49,920	869,764
Natural gas	5,664	18,475	18,387	16,897	28,320	29,056	30,683	31,481	32,259	33,139	34,001	34,885	35,792	36,722	37,677	38,657	39,662	40,693	41,751	584,241
Rapeseed oil	1,842	4,040	10,556	5,235	16,320	16,320	16,320	16,320	16,320	16,320	16,320	16,320	16,320	16,320	16,320	16,320	16,320	16,320	16,320	266,473
Fuel	6,773	8,883	9,707	18,765	23,160	23,762	24,380	25,014	25,664	26,331	27,016	27,718	28,439	29,178	29,937	30,773	31,574	32,395	33,237	462,701
Equipment repairs	6,110	17,310	41,786	50,608	55,320	55,819	56,321	56,828	57,339	57,855	58,376	58,901	59,431	59,966	60,506	61,050	61,599	62,153	62,712	999,990
Field equipment rental	1,403	1,655	9,524	12,002	12,770	12,720	12,720	12,720	12,720	12,720	12,720	12,720	12,720	12,720	12,720	12,720	12,720	12,720	12,720	216,264
Bad debt expenses	682	603	400	430	2,160	2,160	2,160	2,160	2,160	2,160	2,160	2,160	2,160	2,160	2,160	2,160	2,160	2,160	2,160	34,405
Sub-Total	114,457	235,372	293,301	314,625	474,720	483,296	492,620	501,465	510,695	520,332	530,394	540,899	552,671	564,169	576,182	588,709	601,903	615,606	629,927	9,141,423
A. Current Total Outflows	131,357	265,412	332,735	355,448	516,474	526,032	536,391	546,327	556,707	567,556	578,895	590,746	604,537	616,930	630,519	644,787	659,652	675,200	691,466	10,026,571
Current Inflows																				
Pellets sold	82,245	290,405	507,668	323,017	770,000	770,000	770,000	770,000	770,000	770,000	770,000	770,000	770,000	770,000	770,000	770,000	770,000	770,000	770,000	12,753,335
Value of inventory	24,929	63,501	59,862	166,770	70,000	70,000	70,000	70,000	70,000	70,000	70,000	70,000	70,000	70,000	70,000	70,000	70,000	70,000	70,000	1,365,142
B. Current Total Inflows	107,174	353,906	567,530	489,787	840,000	840,000	840,000	840,000	840,000	840,000	840,000	840,000	840,000	840,000	840,000	840,000	840,000	840,000	840,000	14,118,477
C. Current Cash Flows	−24,183	88,574	234,795	134,339	323,526	313,968	303,609	293,673	283,293	272,444	261,105	249,254	236,063	223,070	209,481	195,213	180,348	164,800	148,534	4,091,906
Capital Outflows																				
Plant and field equipment	281,673	6,537		110,835		84,340				84,340				84,340				84,340		736,405
Buildings and storage	224,995		47,086																	272,081
Plant site	46,871																			46,871
Development cost	48,605	1,705																		50,310
Power generators	70,462									70,462									70,462	211,386
D. Total Capital Outflows	672,606	8,242	47,086	110,835		84,340				154,802				84,340				84,340	70,462	1,317,133
Debt Service Outflows																				
Interest	7,847	30,674	29,464	28,153	26,737	25,205	23,548	21,756	19,187	17,721	15,453	13,000	10,348	7,478	4,375	1,093				282,039
Repayment	3,531	14,837	16,088	17,354	18,774	20,306	21,963	23,755	25,694	27,790	30,058	32,511	35,163	38,033	41,136	33,007				400,000
Interest on short term debts	18,069	31,164	31,222	36,964	36,964	36,964	36,964	36,964	36,964	36,964										339,203
E. Total Debt Service Outflows	29,447	76,675	76,774	82,471	82,475	82,475	82,475	82,475	81,845	82,475	45,511	45,511	45,511	45,511	45,511	34,100				1,021,242
Capital Inflows																				
Borrowing	535,000																			535,000
Shares Equity	159,500																			159,500
F. Total Capital Inflow	694,500																			694,500
Total Cash Flow (C-D-E+F)	-31,816	3,657	110,935	-58,967	241,051	147,153	221,134	211,198	201,448	35,167	215,594	203,743	190,552	93,219	163,970	161,113	180,348	80,460	78,072	2,448,031
Cumulative Total Cash Flows	-31,816	-28,159	82,776	23,809	264,860	412,013	633,147	844,345	1,045,793	1,080,960	1,296,554	1,500,297	1,690,849	1,784,068	1,948,038	2,109,151	2,289,499	2,369,959	2,448,031	

TABLE 15

CASH FLOWS PROJECTIONS FOR SMOKY LAKE ALFALFA PROCESSING PLANT: A SUMMARY TABLE 1972-1990

Year	Capital Outflows	Debt Service Outflows	Fixed Costs	Variable Costs	Total Outflows	Capital Inflows	Current Inflows	Total Inflows	Cash Flow
	$	$	$	$	$	$	$	$	$
1	672,686	29,447	16,900	114,457	833,490	694,500	107,174	801,674	-31,816
2	8,242	76,675	30,040	235,372	350,329		353,986	353,986	3,657
3	47,086	76,774	39,434	293,301	456,595		567,530	567,530	110,935
4	110,835	82,471	40,823	314,625	548,754		489,787	489,787	-58,967
5		82,475	41,754	474,720	598,949		840,000	840,000	241,051
6	84,340	82,475	42,736	483,296	692,847		840,000	840,000	147,153
7		82,475	43,771	492,620	618,866		840,000	840,000	221,134
8		82,475	44,862	501,465	628,802		840,000	840,000	211,198
9		81,845	46,012	510,695	638,552		840,000	840,000	201,448
10	154,802	82,475	47,224	520,332	804,833		840,000	840,000	35,167
11		45,511	48,501	530,394	624,406		840,000	840,000	215,594
12		45,411	49,847	540,899	636,257		840,000	840,000	203,743
13		45,511	51,866	552,671	650,048		840,000	840,000	190,552
14	84,340	45,511	52,761	564,169	746,781		840,000	840,000	93,219
15		45,511	54,337	576,182	676,030		840,000	840,000	163,970
16		34,100	55,998	588,789	678,887		840,000	840,000	161,113
17			57,749	601,903	659,652		840,000	840,000	180,348
18	84,340		59,594	615,606	759,540		840,000	840,000	80,460
19	70,462		61,539	629,927	761,928		840,000	840,000	78,072
TOTAL	1317,133	1021,242	885,148	9141,423	12369,946	694,500	14118,477	14812,977	2,448,031

TABLE 16

DISCOUNTED CASH FLOWS (1972-1990), SMOKY LAKE ALFALFA PROCESSING PLANT

Year	Cash Flow	Discount-ing factor at 5%	Present value of cash flow	Discount-ing factor at 6%	Present value of cash flow	Discount-ing factor at 8%	Present value of cash flow
1	-726,316	.952	-691,453	.943	-684,916	.926	-672,567
2	3,657	.907	3,317	.890	3,255	.857	3,134
3	110,935	.864	95,848	.840	93,185	.794	88,082
4	- 58,967	.823	- 48,530	.792	- 46,702	.735	- 43,341
5	241,051	.784	188,984	.747	180,065	.681	164,156
6	147,153	.746	109,776	.705	103,745	.630	92,706
7	221,134	.711	157,227	.665	147,054	.583	128,921
8	211,198	.677	142,981	.627	132,421	.540	114,047
9	201,448	.645	129,934	.592	119,257	.500	100,724
10	35,167	.614	21,592	.558	19,623	.463	16,282
11	215,594	.585	126,122	.527	113,618	.429	92,490
12	203,743	.557	113,485	.497	101,260	.397	80,886
13	190,552	.530	100,992	.469	89,369	.368	70,123
14	93,219	.505	47,075	.442	41,203	.340	31,694
15	163,970	.481	78,869	.417	68,375	.315	51,650
16	161,113	.458	73,790	.394	63,478	.292	47,045
17	180,348	.436	78,632	.371	66,909	.270	48,694
18	80,460	.416	33,471	.350	28,161	.250	20,115
19	78,072	.396	30,916	.331	25,842	.232	18,113
TOT.	1,753,531	12.087	793,028	11.157	665,202	9.602	452,954

Table 16 (con't)

Discounting factor at 10%	Present value of cash flow	Discounting factor at 12%	Present value of cash flow	Discounting factor at 14%	Present value of cash flow	Discounting factor at 15%	Present value of cash flow	Discounting factor at 16%	Present value of cash flow
.909	-660,221	.893	-648,600	.877	-636,979	.870	-631,895	.862	-626,084
.826	3,021	.797	2,915	.769	2,812	.756	2,765	.743	2,717
.751	83,312	.712	78,986	.675	74,881	.685	72,995	.641	71,109
.683	- 40,274	.636	- 37,503	.592	- 34,908	.572	- 33,729	.552	- 32,550
.621	149,693	.567	136,676	.519	125,105	.497	119,802	.476	114,740
.564	82,994	.507	74,506	.456	67,102	.432	63,570	.410	60,333
.513	113,442	.452	99,952	.400	88,454	.376	83,146	.354	78,281
.467	98,629	.404	85,324	.351	74,130	.327	69,062	.305	64,415
.424	85,414	.361	72,723	.308	62,046	.284	57,211	.263	52,981
.386	13,574	.322	11,324	.270	9,495	.247	8,686	.227	7,983
.350	75,458	.287	61,875	.237	51,096	.215	46,353	.195	42,041
.319	64,994	.257	52,362	.208	42,378	.187	38,100	.168	34,229
.290	55,260	.229	43,636	.182	34,680	.163	31,060	.145	27,630
.263	24,516	.205	19,110	.160	14,915	.141	13,144	.125	11,652
.239	39,189	.183	30,006	.140	22,956	.123	20,168	.108	17,709
.218	35,122	.163	26,261	.123	19,261	.107	17,239	.093	14,983
.198	35,709	.146	26,331	.108	19,477	.093	16,772	.080	14,429
.180	14,483	.130	10,460	.095	7,644	.081	6,517	.069	5,552
.164	12,804	.116	9,056	.083	6,480	.070	5,465	.060	4,684
8.365	287,119	7.367	155,400	6.553	51,581	6.199	6,431	5.875	-33,166

TABLE 17

THE EFFECT OF THE CHANGING RATE OF INTEREST ON THE NET PRESENT VALUE: SMOKY LAKE PROJECTED CASH FLOWS

Cash Flow Discounted by	Net Present Value
(%)	($)
5	793,028
6	662,202
8	452,954
10	287,119
12	155,400
14	51,581
15	6,431
16	-33,166

shows the effect of the rate of interest on the net present value. If the rate of interest was 16 percent, it would pay to invest in the alternative project because a negative net present value would mean a loss to the investor.

The internal rate of return was defined as the rate of discount which makes the present value zero. On this basis, the rates of 15 percent and 16 percent were interpolated to obtain the true rate of return. The formula for interpolation is reproduced for convenience as follows:

$$\text{Internal Rate of Return} = \text{Lower Discount Rate} + \text{Difference Between the Discount} \left[\frac{\text{Present Value of Cash Flow at the Lower Discount Rate}}{\text{Absolute Difference Between Values of Cash Flow at the Two Discount Rates}}\right]$$

$$\begin{aligned} R &= 15 + 1\left(\frac{6431}{39597}\right) \\ &= 15 + 1\ (0.2) \\ &= 15 + 0.2 \\ &= 15.2\ \% \end{aligned}$$

Thus, the internal rate of return is 15.2 percent for the Smoky Lake Processing Plant, with a throughput of 75.0 percent capacity and a selling price of $70 per ton of pellets. The plant is capable of earning back all the capital and operating costs expended upon it as long as the opportunity cost of capital is less than 15.2 percent.

Results of Sensitivity Analysis

The results of the sensitivity analysis are based on the three assumptions already stated. Using varying prices and capacities, the results of undiscounted cash flows are contained in Tables 18, 19 and 20.

According to Table 19, the output necessary for the plant to cover all costs at the price of $70 per ton of pellets lies somewhere between throughputs of 40 and 60 percent of capacities. But if the price per ton of pellets was $100, according to Table 20, the plant would realize a positive cash flow at a 40 percent level of throughput capacity. The specific values will appear later in graphic presentation.

Following the sensitivity analysis, the earning power of Smoky Lake plant is shown in Table 21. At the most likely price of $70 per ton of pellets, the earning power of the plant could increase to 22 percent if the throughput were raised to 95 percent of full capacity, or 15,200 tons per year. Alternatively, the yield would be negative if the throughput was 40 percent of capacity. At the price of $50 per ton of pellets, the financial rate of return is negative at all levels of throughout. On the other hand, at the price of $100 per ton of pellets, the financial rate of return for the plant is very attractive, even at the throughput of 40 percent capacity.

The results for both the most likely projections and the sensitivity analysis are presented below in graphical form.

TABLE 18

SENSITIVITY ANALYSIS: UNDISCOUNTED CASH FLOWS AS RELATED TO VARYING THROUGHPUT AT A PRICE OF $50 PER TON OF PELLETS SOLD: SMOKY LAKE ALFALFA PROCESSING PLANT, 1972-1990

	Throughput Capacity			
	40 Percent $	60 Percent $	75 Percent $	90 Percent $
Gross Revenue	6, 318,477	8,716,477	10,518,477	12,918,477
Variable Costs	5,395,097	7,504,690	9,141,423	11,351,014
Gross Margin	923,380	1,211,787	1,377,054	1,567,463
Fixed Costs	3,223,523	3,223,523	3,223,523	3,223,523
Cash Flows	-2,300,143	-2,011,736	-1,846,469	-1,656,060

TABLE 19

SENSITIVITY ANALYSIS: UNDISCOUNTED CASH FLOWS AS RELATED TO VARYING THROUGHPUT AT A PRICE OF $70 PER TON OF PELLETS SOLD: SMOKY LAKE ALFALFA PROCESSING PLANT, 1972-1990

	Throughput Capacity			
	40 Percent $	60 Percent $	75 Percent $	90 Percent $
Gross Revenue	8,238,477	11,598,477	14,118,477	17,478,477
Variable Costs	5,395,097	7,504,690	9,141,423	11,351,014
Gross Margin	2,843,380	4,093,787	4,977,054	6,127,463
Fixed Costs	3,223,523	3,223,523	3,223,523	3,223,523
Cash Flows	- 380,143	870,264	1,753,531	2,903,940

TABLE 20

SENSITIVITY ANALYSIS: UNDISCOUNTED CASH FLOWS AS RELATED TO VARYING THROUGHPUT AT A PRICE OF $100 PER TON OF PELLETS SOLD: SMOKY LAKE ALFALFA PROCESSING PLANT, 1972-1990

	Throughput Capacity			
	40 Percent $	60 Percent $	75 Percent $	90 Percent $
Gross Revenue	11,118,477	15,918,477	18,518,477	24,318,477
Variable Costs	5,395,097	7,504,690	9,141,423	11,351,014
Gross Margin	5,723,380	8,413,787	10,377,054	12,967,463
Fixed Costs	3,223,523	3,223,523	3,223,523	3,223,523
Cash Flows	2,499,857	5,190,264	7,153,531	9,743,940

TABLE 21

THE FINANCIAL RATE OF RETURN DUE TO VARYING PRICE AND THROUGHPUT: SMOKY LAKE ALFALFA PROCESSING PLANT, 1972-1990

Price per Ton	Financial Rate of Return			
($)	Throughput at 40% Capacity	Throughput at 60% Capactiy	Throughput at 75% Capacity	Throughput at 90% Capacity
50	0	0	0	0
70	0	10	15	22
100	19	28	33	38

Figure 4 indicates the relationship between the set pellet price of $50 per ton and the varying throughput percent of capacity. The total cost curve lies above the total revenue curve and the fixed costs are not covered unless throughput exceeds 18 percent of capacity. When the pellet price is set at $70 (Figure 5), the total cost curve lies above the total revenue curve only at a throughput of equal or less than 46 percent of capacity; beyond that level of throughput, the total revenue curve lies above the total cost curve. Therefore, given the pellet price of $70 per ton, total costs will be covered only if throughput percent of capacity exceeds 46 percent. On the other hand, according to Figure 6, if the price was raised to $100, a throughput capacity of 26 percent would ensure that the plant does not lose or gain any monies.

A historical throughput and throughput precent of capacity has been included for the purpose of comparison. Table 22 gives the actual throughput and throughput percent of capacity for Smoky Lake Alfalfa Processing Plant based on a throughput of 16,000 tons per year. Table 22 also shows the actual throughput percent of capacity based on the assumption of 12,000 tons per year. According to the most likely assumption on throughput of 12,000 tons per year and a pellet price of $70 per ton, the actual average percent of capacity is 50.74 percent which is just above the 46 percent of capacity required for total revenue to equal total costs.

Figure 4

SENSITIVITY ANALYSIS: CASH FLOWS PROJECTIONS FOR SMOKY LAKE ALFALFA PROCESSING PLANT AS RELATED TO THROUGHPUT AT A PRICE OF $50 PER TON OF PELLETS SOLD

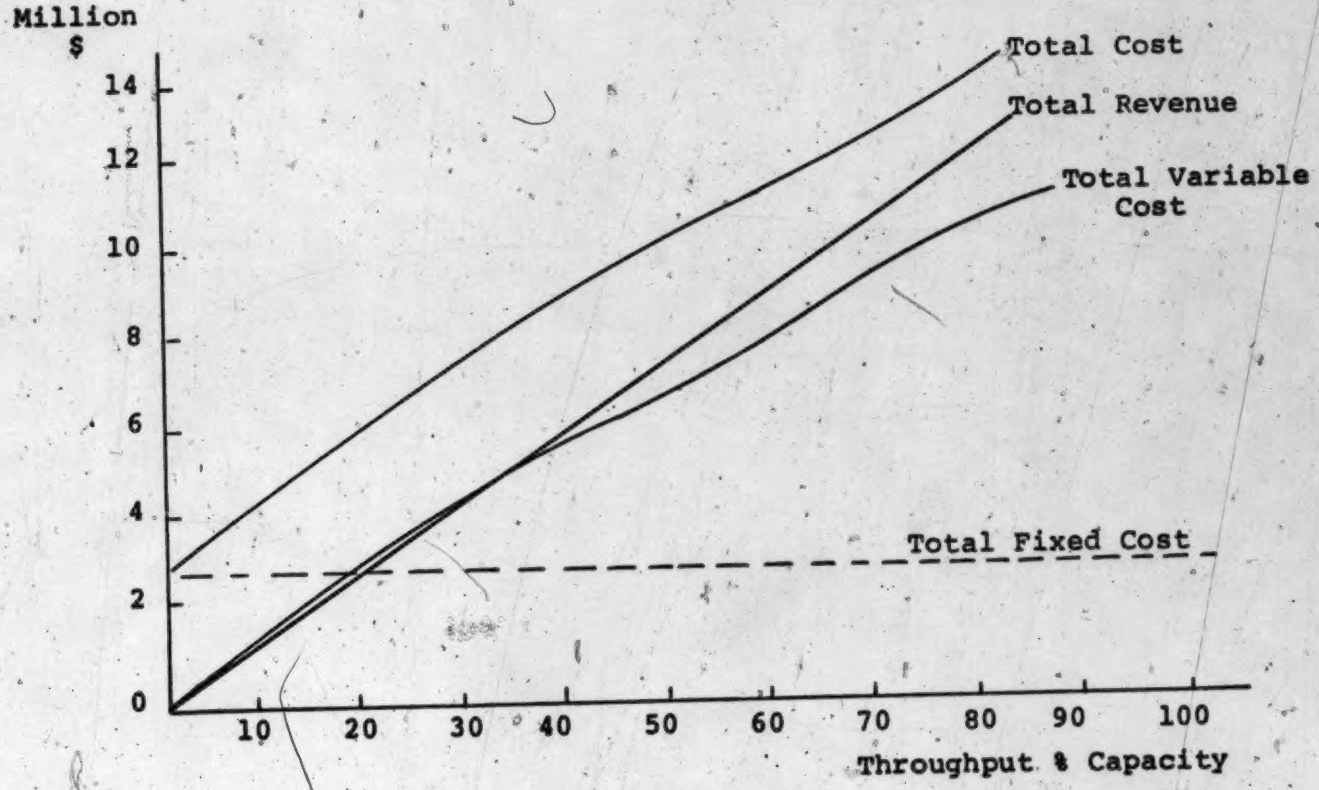

Figure 5

SENSITIVITY ANALYSIS: CASH FLOWS PROJECTION FOR SMOKY LAKE ALFALFA PROCESSING PLANT AS RELATED TO VARYING THROUGHPUT AT A PRICE OF $70 PER TON OF PELLETS SOLD

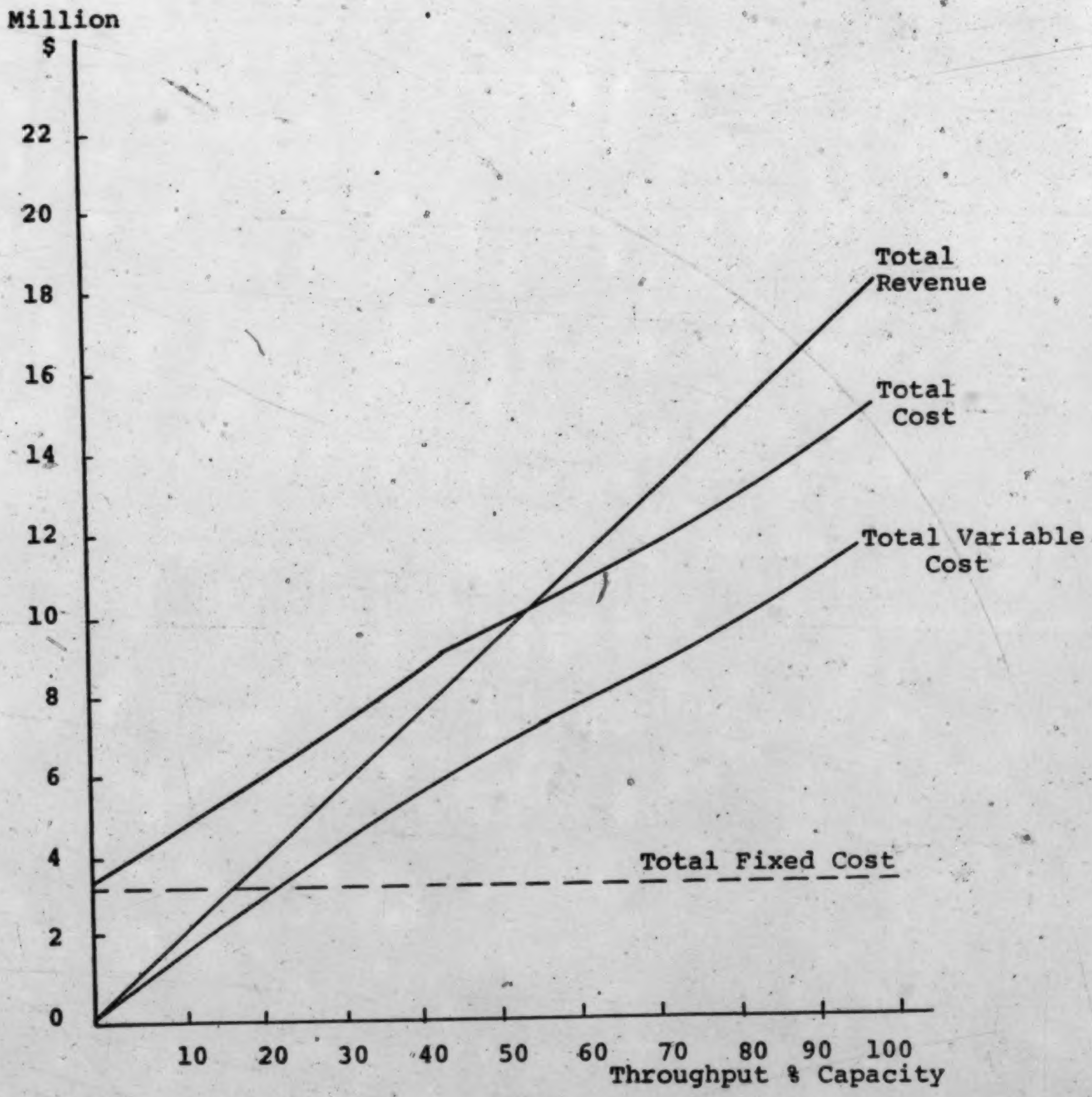

Figure 6

SENSITIVITY ANALYSIS: CASH FLOWS PROJECTIONS FOR SMOKY LAKE ALFALFA PROCESSING PLANT AS RELATED TO VARYING THROUGHPUT AT A PRICE OF $100 PER TON OF PELLETS SOLD

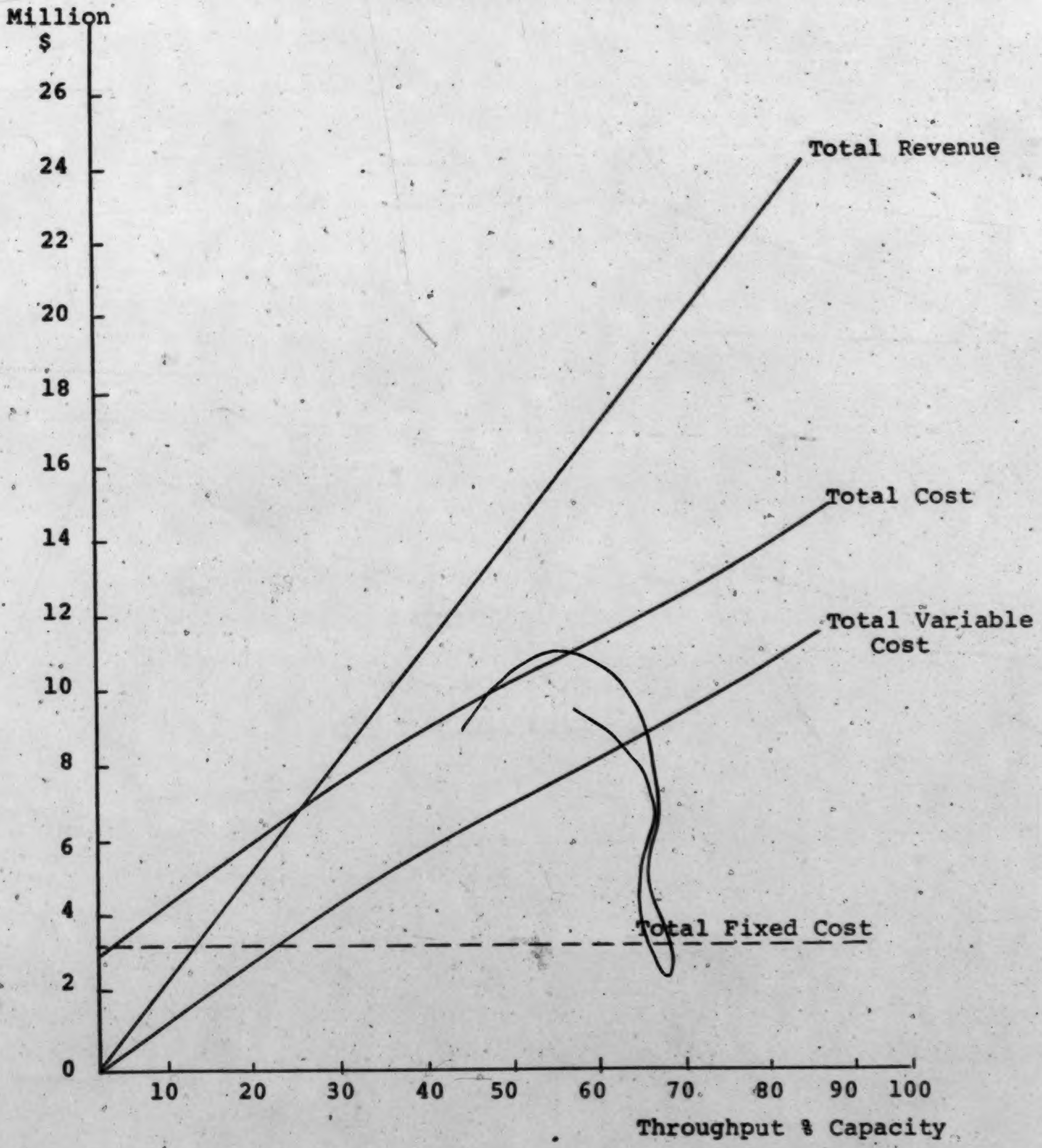

TABLE 22

A HISTORICAL THROUGHPUT OF CAPACITY RATIOS: SMOKY LAKE ALFALFA PROCESSING PLANT, 1972-1975

Year	Actual Full Capacity	Throughput	% of Capacity	Assumed Capacity[1]	% of Capacity[2]
	(tons)	(tons)		(tons)	
1972	16,000	3,335	20.84	12,000	27.79
1973	16,000	7,649	47.80	12,000	63.74
1974	16,000	7.734	48.33	12,000	64.45
1975	16,000	5,638	35.23	12,000	46.98
TOTAL	64,000	24,356	152.20	48,000	202.96
Average	16,000	6,089	38.05	12,000	50.74

Source: Clarkson, Gordon and Co., Chartered Accountants, "Smoky Lake Alfalfa Processors Financial Records, March 31, 1972, 1973, 1974 and 1975."

[1] Indicates the most likely assumption of 75 percent of capacity or a throughput of 12,000 tons per year.

[2] An historical percent of capacity based on a throughput of 12,000 tons per year.

CHAPTER IV

A MODEL FOR REGIONAL ECONOMIC IMPACT ANALYSIS

Linear Programming Models

Examination of the competitive impact of alfalfa production on other farm enterprises in Smoky Lake County and the regional impact of the Smoky Lake Alfalfa Plant are objectives of this study. A linear programming model for Northern Alberta agriculture[1] is employed for the purpose of examinating this economic impact.

Linear programming is a computational technique used to determine in numerical terms optimum allocations of resources required to reach a stated objective. In other words, linear programming provides a method for allocating the best plan for achieving the stated objectives in a situation in which resources are limited. In general, therefore, a problem of linear programming is that of finding non-negative values of a number of variables for which a certain linear function of those variables assumes the greatest (or the least) possible value while subject to certain linear inequalities.

The first explicit use of linear programming techniques occurred in connection with the planning activities of the United States Air Force during the period immediately following

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[1] L.P. Apedaile, "A Model of Agricultural Technology for Policy Analysis in Northern Alberta. Interim Report, March, 1975." (A report written for Alberta Agriculture Research Trust Grant 55-28025).

World War II.[1] It was, Dantzig who formulated the general linear programming problem and developed the simplex method of solution. As often happens, however, the development of novel tools of analysis suggested applications in fields that were quite different from those to which the tools were initially intended to apply. Since that time the subject has received widespread application in both industry and government.

Linear programming has been used as a research tool by apricultural economists to:

1. Specify the optimum organization of resources and enterprise on farms.

2. Suggest desirable farm adjustments.

3. Specify profit maximizing mixes of commodities produced by marketing firms.

4. Specify cost minimizing methods of processing products such as fertilizer or mixed feeds.

5. Specify spatial equilibrium patterns in the flow of agricultural products to indicate optimum interregional patterns of resource use and product specialization in agriculture and to solve related types of problems.[2]

Assumptions

Several assumptions are used in linear programming. Heady and Candler warn, however, that "if these assumptions do not apply to the problem under consideration, linear programming may not provide a sufficiently precise solution."[1] Their assumptions are stated below:

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[1] Full details are given in G.B. Dantzig, "Maximization of a Linear Function of Variables to Linear Inequalities." Activity Analysis of Production and Allocation, edited by T.C. Koopmans, (New York: McGraw-Hill Book Company, Inc., 1951), pp. 339-347.

[2] Earl O. Heady and Wilfred Candler. Linear Programming Methods (Ames: Iowa State University Press, 1960) p. 7.

1. Additivity and Linearity: The activities must be additive in the sense that when two or more are used, their product must be the sum of their individual products. An equivalent statement is that the total amount of resources used by several enterprises must be equal to the sum of the resources used by each individual enterprise. Thus, no interaction is possible in the amount of resources required per unit of output regardless of whether activities are produced alone or in various proportions. Similarly, increasing returns to scale for single processess are not allowed, since equal additional inputs do not add equal amounts to output.

2. Divisibility: It is assumed that factors can be used and commodities can be produced in quantities which are fractional units. That is, resources and products are considered to be continuous-- to be infinitely divisible. Linear programming will therefore specify a program of activities which uses .7 of the land or .994 of the labour supplies available. They go on to say that this assumption is not a serious limitation since a program ordinarily can be rounded to include activities produced to the nearest whole unit without causing serious decision-making errors.

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[1] Ibid., pp. 17-18.

3. Finiteness: It is assumed that there is a limit to the number of alternative activities and to the resource restrictions which need be considered. This is a practical assumption. If the farmer, businessman, or planner had a unlimited number of alternatives, he would never have them programmed because he could never finish the computational task of determining the most profitable programme.

4. Single-Value Expectations: In general, the linear programming methods used widely to date employ the standard linear programming assumption that resource supplies, input-output coefficients, and prices are known with certainty. This assumption is unrealistic for certain farming situations. However, this 'self-secure' assumption is used in conventional research techniques such as budgeting. In this regard, linear programming provides solutions which are as realistic as those from other methods which employ the same assumptions.[1]

Problem Formulation

Linear programming problems are generally expressed as follows:

$$\text{Maximize (minimize) } Z = C_1X_1+C_2X_2+\ldots C_nX_n$$

Subject to:

$$A_{11}X_1+A_{12}X_2+\ldots\ldots A_{1n}X_n \;(\;=\;)\; b_1$$
$$A_{21}X_1+A_{22}X_2+\ldots\ldots A_{2n}X_n \;(\;=\;)\; b_2$$
$$A_{m1}X_1+A_{m2}X_2+\ldots\ldots A_{mn}X_n \;(\;=\;)\; b_m$$

$$\left.\begin{array}{l} X_i \geq 0 \\ b_i \geq 0 \end{array}\right. \quad \text{for all i.}$$

---

[1] Ibid.

The simplex method is one of the techniques which may be used to find the maximum (minimum) of the objective function subject to the constraints given.

Objective Function

All linear programming problems are concerned with either minimizing or maximizing something. It is not necessary to classify linear programming problems into two types, according to whether the objective function is to be minimized or maximized. This is because every time a quantity is maximized, some other quantity, for example its negative, is minimized. As such, there is no conceptual difference between the two operations.

Given several methods or processes-- different enterprises and different techniques of producing the enterprises-- by which the objective can be attained, we choose from among them the methods or processes which are most efficient in converting resources into the objective.

A linear programming problem also does not exist unless some resources (land, labour or capital) are restricted or limited. For most planning or choice problems there are restrictions which set limits on the kinds of plans that can be considered. Although the fixed resources represent the main type of restrictions, they may also be other restrictions such as institutions.

Solving Linear Programming Problems

There is no known direct method for solving linear programming problems. In view of this fact, solving linear programming problems involves iterative solutions, i.e., solutions are carried out in a number of steps or iterations, each of which brings the problem closer to solution.

Dantzig's simplex method is one of a number of methods of solution in use. Others include the complete description method of Motzkin, Raiffa, Thompson and Thrall and solution by elimination. For unsophisticated problems, graphic methods of solution may suffice. Solution by elimination is not practically useful because it depends on knowing in advance the restraints that will be binding. On the other land, graphic solution is only practical when there are only two restraints. When the number of unknowns exceeds three, a geometric solution is impossible.

The simplex method makes use of slack or disposal variables which permit us to replace the inequalities by equalities. For example,

$$a_{i1} + X_1 + \dots a_{in}X_n \leq C_i$$

Suppose this inequality is replaced by the equation:

$$a_{i1} + X_1 + \dots A_{in}X_n + X_{n+i} = C_i$$

where:

$X_{n+i} \geq 0$ and conversely, the new variable X_{n+i} is known as a slack variable because it merely accounts for the excess of the right hand side over the left hand side.

Computational Procedures

The starting point in linear programming is to obtain the basic data and define the problem to be solved (such as maximum output or selecting a combination of enterprises which will maximize profits). In any case, the program selected must be feasible. A feasible program is one which does not have total resource requirements exceeding total resource supplies.

Given the resource supplies and the input-output coefficients, a system of relationships can be established which defines the production possibilities and states the profit function equation.

For example, suppose the problem to be solved is:

Maximize $A = 30X_1 + 10X_2 + 40X_3$

Subject to:

$4X_1 + 2X_2 + X_3 \leq 100$

$X_1 + X_2 + X_3 \leq 120$

$10X_1 + 5X_2 - 4X_3 \leq 88$

and that:

$X_1; X_2$ and $X_3 \geq 0.$

In order to apply the simplex method, the inequalities are first converted to equalities. This is done by adding the non-negative slack varable (disposal activity) so that the left-hand side of the equation is equal to the right-hand side of the equation.

For example:

$$4X_1 + 2X_2 + X_3 + X_4 + 0X_5 + 0X_6 = 100$$

$$X_1 + X_2 + 3X_3 + 0X_4 + X_5 + 0X_6 = 120$$

$$10X_1 + 5X_2 + 4X_3 + 0X_4 + 0X_5 + X_6 = 88$$

and $$Z = 30X_1 + 10X_2 + 40X_3 + 0X_4 + 0X_5 + 0X_6$$

The establishment of the initial feasible program or the basic feasible solution (BFS) in which real activities at zero levels and disposal activities are equal to resource supplies is the first task of the simplex method. Profits will be zero in the basic feasible solution until real activities enter. The simplex method systematically solves the linear programming problem in such a way that the objective function changes monotonically to converge with its optimum. In the process each iterative feasible solution is checked to determine if it is the optimal solution.

Limitations

A linear programming model is not an economic model yielding estimates of real world situations but is a mathematical statement of an objective which is optimised within the stated constraints. As such, any linear programming model is limited by two main factors.

1. The researcher's ability to describe in mathematical terms all realistic constraints.

2. The resources available for developing a robust

enough model to express all possibilities which are important to the maximizing function.
Therefore a linear programming model such as the linear programming model for Northern Alberta agriculture applied to the Smoky Lake situation is not free from these limitations. The regional economic impact analysis is based on a sample survey whose observed facts cannot be taken as facts regarding the population. The problems involved in summarising accurate input/output data and deciding on relevant prices and suitable resource restrictions make the limitations very real.

The Model

The model of agricultural technology for policy analysis in Northern Alberta is an attempt to develop a regional or national model that is designed to give a full picture for policy alternatives. The model is employed in this study for the following reasons:

1. It provides a comparative analysis of agriculture resource utilization in Northern Alberta under various policy alternatives using disaggregated regional data;
2. It contains artificially imposed constraints; and
3. It is designed in such a way that more data can be added and a wide range of policy programs can be considered.

The model consists of columns, rows and the right-hand sides. The elements are listed by column order and row order. The number of elements by row order excludes the right-hand side but includes one slack variable for each row.

The model is a single period non-stochastic linear program of one agricultural region, Northern Alberta. There are 104 activities and 98 constraints. Out of these 104 activities, there are 57 primary producing activities, and 46 exchange and accounting activities. The prices and costs for the activity rows are based on Alberta averages for 1974 and from the primary data (Appendix 7). In the 98 rows, there are 9 land constraints, 4 labour constraints, 3 cash constraints, 3 fertilizer constraints, 5 equipment constraints and 12 livestock constraints. The right-hand constraints were developed from 1971 Census figures and from assumptions on resource availability in the County of Smoky Lake. The right-hand constraints used are contained in Table 23. The matrix structure of the model is indicated in Table 24, part A., while part B shows the summary of the matrix. The identification of the letter codes used is contained in Appendix 8.

Cash flow is the objective function. It is maximized by minimizing an equation which expresses all income or receipts with negative signs and all outflows or cost expenditures with positive signs. The structure of the model is flexible and it allows the formation of various objective functions for future analyses. For example, for future analysis, one could maximize the value of production or minimize the cash expenditure.

TABLE 23

TECHNOLOGY MODEL FOR NORTHERN ALBERTA - RIGHT-HAND SIDE CONSTRAINTS FOR SMOKY LAKE COUNTY

Constraining Activity	Figure Used	Source
Fal 1+2	18,903 acres	Alberta Land Use Forum Tech. Report 5
FAL 3	18,490 acres	Alberta Land Use Forum
FAL 4	23,421 acres	Alberta Land Use Forum
STUB 1+2	53,596 acres	Alberta Land Use Forum
STUB 3	52,425 acres	Alberta Land Use Forum
STUB 4	66,405 acres	Alberta Land Use Forum
IP-PAS	22,121 acres	Alberta Land Use Forum
COM-PAS	115,428 acres	ADA, Farm Statistics
NT-PAS	59,189 acres	Alberta Land Use Forum
L-N A	1,575,000 hours	Number of Commercial farms times 1.5 labour units times 1200 hours per period
L-M J	525,000 hours	Number of Commercial farms times 1.5 labour units times 400 hours per period
L-J A	525,000 hours	Number of Commercial farms times 1.5 labour units times 400 hours per period
L-S O	525,000 hours	Number of commercial farms times 1.5 labout units times 400 hours per period
L-TOTL	3,150,000 hours	Total of above labour periods
BOT-EQ	5,002,911 ($)	Total value machinery, grain inventory and livestock at 0.5 lending factor.
MTR-PR	904,000 hours	Number of middle tractors in county times 1000 available hours
LTR-PR	475,000 hours	Number of largest tractors in county times 1000 available hours
SWA-PR	156,000 hours	Number of swathers in county times 400 available hours

TABLE 23 (con't)

Constraining Activity	Figure Used	Source
COM-PR	208,000 hours	Number of combines in the county times 400 available hours
COW-UN	2,409 head	1971 census of cows and heifers over two year sin county
PR-C-UN	23,062 head	1971 census replacement heifers between 1 and 2 years in county
SOW-UN	28,893 head	1971 census breed sows in county
SOW-RP	6,571 head	1971 census replacement breeding sows in county

TABLE 24 Part A

TECHNOLOGY MODEL FOR NORTHERN ABLERTA: MATRIX STRUCTURE

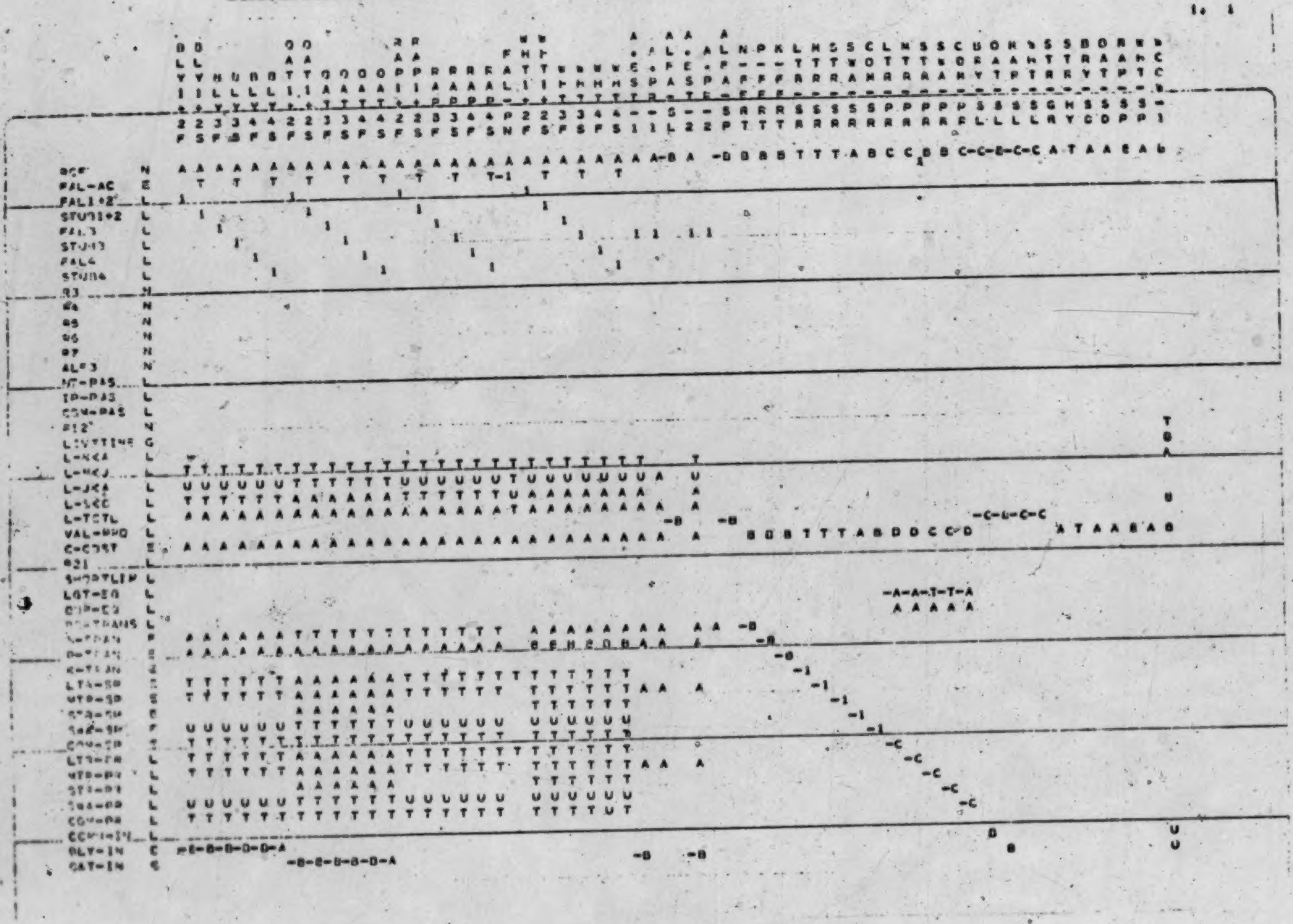

TABLE 24 Part A (con't)

```
                                            W S S S       F S         S   W W W                                               1, 2
                                            C Y Y Y S S S A C   S S   F   C C C     L                         G
              W W W W W W W W S S S S S S S U G G G Y Y Y T U B C C S D   A A A B B G S S B W H C B H P P H C R
              C C C C C F F F C C C Y Y Y F L - - - G G G B L U C A C R R F F F - - T O O O E O S O A - - A C N
              O O A A A C D D C O O L L L C C 1 2 3 - - - Z C L W F A - P - - - C L - W W R N G O R Y T N Y M F
              W W F F F R R R W W W G G G R W V V V 1 2 3 F W L V V F 1 C 1 2 3 A O H - - - - - B - - - - - F E C
              - - - - - - - - - - - - - - - S A A A S S S S S S A A S S S S S S S N A U B B S S - S P P P P A E R
              2 3 1 2 3 1 2 3 1 2 3 1 2 3 1 L D D D L L L L L L D D L L L L L L H G L N T T D D S D N N N R S D C

RCF       N   B B B B B B B B A A A A A A A-C-B-C-C-D-C-C-C-C-C-C-B-B-C-C-D-B-E B E C E B D-B-D-B-B A A 1 B A A
FAL-AC    E
FAL1+2    L                                                                                                     E
STUB1+2   L                                                                                                     E
FAL3      L                                                                                                     E
STUB3     L                                                                                                   1 E
FAL4      L                                                                                                     E
STUB4     L                                                                                                     E
R3        N
R4        N
R5        N
R6        N
R7        N
ALF3      N
NT-PAS    L                                                                                             1       E
IP-PAS    L                                                                                           1         E
COM-PAS   L                                                                                                 1   F
R12       N
LIVETIME  G   T T
L-N<A     L   B B A A B A A A T V   T V                                                                         G
L-M<J     L   A A A A A A A A A T U A T U                                                           V T T       F
L-J<A     L                   A 1 T A 1 T                                                           A T T     T F
L-S<O     L                   A T T A T T                                                           U T T     A F
L-TOTL    L   B B A B B A A A A A T A A T                           D                 B             A T T     T G
VAL-PRO   L                                -C      -B-C-C-C-C-C    -B-C-C-B-B-B            -B-B-B-B
C-COST    E   B B B B B B B B A A A A A A A                                    -D B   B B B         A A 1 B A A
R21       L
SHORTLIM  L                                                                     1  -T
LGT-EQ    L                                                                       1                             E
BOP-EQ    L                                                                                                     G
BORTRANS  L                                                                      -1
N-TRAN    E
P-TRAN    E
K-TRAN    E
LTR-SP    E                                                                                         T         T
MTR-SP    E                                                                                         T         T
STR-SP    E
SWA-SP    E
COM-SP    E
LTR-PR    L                                                                                         T         T F
MTR-PR    L                                                                                         T         T F
STR-PR    L                                                                                                     F
SWA-PR    L                                                                                                     F
COM-PR    L                                                                                                     F
COMU-IN   L                       B     A                                                                  -1
BLY-IN    E   A A T A B A A A                                                         C
OAT-IN    E   A A A A A A A B                                                         B
```

TABLE 24 Part A (con't)

```
                                                                                                                          2.  1
               B B         O O         R R           W W         A   A A   A
               L L         A A         A A         F H H         . A L . A L N P K L M S S C L M S S C B O R W S S B O R W W
               Y Y B B B B T T O O O O P P R R R R A T T W W W W E . F E . F - - - T T T W O T T T W C R A A H T T R A A H C
               1 1 L L L L 1 1 A A A A 1 1 A A A A L 1 1 H H H H S P A S P A F F F R R R A M R R R A M Y T P T R R Y T P T G
               + + Y Y Y Y + + T T T T + + P P P P - + + T T T T T R - T R - E E E - - - - - - - - - - - - - - - - - - - - W
               2 2 3 3 4 4 2 2 3 3 4 4 2 2 3 3 4 4 P 2 2 3 3 4 4 - - S - - S R R R S S S S S P P P P P S S S S G M S S S S -
               F S F S F S F S F S F S F S F S F S N F S F S F S 1 1 L 2 2 P T T T R R R R R R R R R R L L L L R Y D D P P 1

RAP-IN     E                          -A-A-A-A-A-A                                                         B
FAL-IN     E
WHT-IN     E                                        -B-B-B-B-B-A                                             B
ALFA-IN    E                                                              -A 1
ALFA-INP   E                                                                    -A 1
HAY-IN     E                                                                                                                 B
HT-P-IN    E
TA-P-IN    E
GRNFD-IN   E                                                                                                                 B
STR-IN     E  -A-A-A-A-A-A-A-A-A-A-A-A              -B-B-B-B-B-B                                                             B
COP-IN     E
BLY-SD     E   T T T T T T                                                                                         -1
OAT-SD     E               T T T T T T                                                                               -1
RAP-SD     E                           T T T T T T                                                                     -1
WHT-SD     E                                         T T T T T T                                                         -1
GRN-ST     E  -B-B-B-B-B-A-B-B-B-B-B-A-B-A-A-A-A-A  -B-B-B-B-B-A                                                 B
HAY-ST     E  -A-A-A-A-A-A-A-A-A-A-A-A              -B-B-B-B-B-B                                                   B
BULLINV    G
COWINV     G                                                                                                                 1
PRCINV     G                                                                                                                 U
WCOW-TR    E                                                                                                                -T
WCULCWSL   E                                                                                                                -U
WCAFINV    G
WCAF-TR    E
SYG-1VAD   E
SYG-2VAD   E
SYG-3VAD   E
SYG-1SL    E
SYG-2SL    E
SYG-3SL    E
WFORINV    L
WFOR-TR    E
FATAFCF    E
SCULCWSL   E
BULL-TR    E
SCOWINV    E
SCAFVAD    E
SCAFSL     E
SFOR-SL    E
RPCSL      E                                                                                                                -V
WCAF-1SL   E
WCAF-2SL   E
WCAF-3SL   E
SOW-UN     L
SOW-SP     L
C-SW-T     E
WENR-T     E
```

TABLE 24 Part A (con't)

2. 2

		WCOW-2	WCOW-3	WCAF-1	WCAF-2	WCAF-3	WFDR-1	WFDR-2	WFDR-3	SCOW-1	SCOW-2	SCOW-3	SYLG-1	SYLG-2	SYLG-3	SFDR-1	WCULCWSL	SYG-1VAD	SYG-2VAD	SYG-3VAD	SYG-1SL	SYG-2SL	SYG-3SL	FATBEFSL	SCULCWSL	BULLSL	SCOWVAD	SCAFVAD	SCAFSL	SFDR-1SL	RPCSL	WCAF-1SL	WCAF-2SL	WCAF-3SL	B-CASM	B-LONG	LGT-BAL	SOW-UN	SOW-BT	BOR-BT	WEN-SD	HCG-SD	CSOW-S	BOR-SD	MAY-PN	P-T-PN	P-N-PN	HAY-PR	COMPAS	GRHFEED	CRC
RAP-IN	E																																																		
FAL-IN	E																																																		
WHT-IN	E																																																		
ALFA-IN	E																																																		
ALFA-INP	E																																																		
HAY-IN	E	B	B	B	B	B	B	B	B																																			-B			-1			
NT-P-IN	E										B			B		B																														-1				
TA-P-IN	E									A			A																																-1					
GRNFD-IN	E	B	B	B	B	B																																											-B	
STR-IN	E	B	B	A	A	B	B	B	B																												B													
COP-IN	E																																																		
BLY-SD	E																																																		
OAT-SD	E																																																		
RAP-SD	E																																																		
WHT-SD	E																																																		
GRN-ST	E																																																		
HAY-ST	E																																											-B						
BULLINV	G									U	U	U																																							
COWINV	G	1	1																																																E
RPCINV	G	U	U																																																
WCOW-TR	E	-T	-T							1	1	1																																							
WCULCWSL	E	-U	-U														1																																		
WCAFINV	G			1	1	1																																													
WCAF-TR	E			-T	-T	-T							1	1	1																																				
SYG-1VAD	E												-T					1																																	
SYG-2VAD	E													-T					1																																
SYG-3VAD	E														-T					1																															
SYG-1SL	E												-T								1																														
SYG-2SL	E													-T								1																													
SYG-3SL	E														-T								1																												
WFDRINV	L						1	1	1																																										
WFDR-TR	E						-T									1																																			
FATBEEF	E							-T	-T															1																											
SCULCWSL	E									-U	-U	-U													1																										
BULL-TR	E									-V	-V	-V														1																									
SCOWINV	E									-T	-T	-T															1																								
SCAFVAD	E									-T	-T	-T																1																							
SCAFSL	E									-T	-T	-T																	1																						
SFDR-SL	E															-T														1																					
RPCSL	E	-V	-V																												1																				
WCAF-1SL	E			-T																												1																			
WCAF-2SL	E				-T																												1																		
WCAF-3SL	E					-T																												1																	
SOW-LN	L																																				1	-A													E
SOW-PP	L																																				U														D
C-SW-T	E																																				-T					1									
WENR-T	E																																				-T			1											

TABLE 24 Part A (con't)

```
                B B         O O         R R           W W         A   A A   A                                                 3. 1
                L L         A A         A A         F H H         . A L . A L N P K L W S S C L H S S C B O R W S S B O R W W
                Y Y B B B B T T O O O O P P R R R R A T T W W W W E . F E . F - - - T T T W O T T T W O R A A H T T R A A H C
                1 1 L L L L 1 1 A A A A 1 1 A A A A L 1 1 H H H H S R A S P A F F F R R R A H R R R A H Y T P T R R Y T P T O
                + + Y Y Y Y + + T T T T + + P P P P - + + T T T T T R - T R - F F S - - - - - - - - - - - - - - - - - - - - W
                2 2 3 3 4 4 2 2 3 3 4 4 2 2 3 3 4 4 P 2 2 3 3 4 4 - - S - - S R R R S S S S S P P P P P S S S S G H S S S S -
                F S F S F S F S F S F S F S F S F S N F S F S F S 1 1 L 2 2 P T T T R R R R R R R R R R E L L L R Y D D P P 1

HOG-TR   E
BOR-TR   E
ALF.BAL1 E                                                       -A 1
ALF.BAL2 E                                                             -A 1
```

TABLE 24 Part A (con't)

```
                                                                                                              3. 2
                                            W S S S       F S         S   W W W
                                            C Y Y Y S S S A C   S S   F   C C C     L                         G
              W W W W W W W W S S S S S S S U G G G Y Y Y T U B C C S D   A A A B B G S S B W H C B H P P H C R
              C C C C C F F F C C C Y Y Y F L - - - G G G B L U O A C R R F F F - - T O O O E O S O A - - A O N
              O O A A A D D D C C O L L L D C 1 2 3 - - - E C L W F A - P - - - C L - W W R N G O R Y T N Y M F
              W W F F F R R R W W W G G G R W V V V 1 2 3 F W L V V F 1 C 1 2 3 A C B - - - - - B - - - - - F E C
              - - - - - - - - - - - - - - - S A A A S S S S S S A A S S S S S S S N A U B B S S - S P P P P A E R
              2 3 1 2 3 1 2 3 1 2 3 1 2 3 1 L D D D L L L L L L D D L L L L L L H G L N T T D D S D N N N R S D C

HOG-TR   E                                                                           -B       1
BOR-TR   E                                                                           -T  -1       1
ALF.BAL1 E
ALF.BAL2 E
```

TABLE 24 Part B

TECHNOLOGY MODEL FOR NORTHERN ALBERTA: MATRIX SUMMARY

```
        TECH.MODEL N.ALTA                                                        PAGE    5  -  76/103

        SUMMARY OF MATRIX

SYMBOL          RANGE                    COUNT (INCL.RHS)

  Z          LESS THAN          .000001
  Y       .000001  THRU         .000009
  X       .000010               .000099
  W       .000100               .000999
  V       .001000               .009999     9
  U       .010000               .099999    76
  T       .100000               .999999   316
  1      1.000000              1.000000    97
  A      1.000001             10.000000   313
  B     10.000001            100.000000   170
  C    100.000001          1.000.000000    37
  D  1.000.000001         10.000.000000     5
  E 10.000.000001        100.000.000000    11
  F 100.000.000001     1.000.000.000000     9
  G       GREATER THAN 1.000.000.000000     3
```

Apart from various objective functions, the model includes shadow prices, dual problems and the marginal cost. The shadow prices represent the marginal value products of the corresponding resources. They indicate possible gains through acquisition of scarce resources, and they serve as a basis for computing the total value product and, therefore, as one check on computations. The dual problem is to find the value of resources such that the total value of resources is the minimum consistent with no activity having an imputed surplus. The marginal cost is the increase in total costs resulting from a one-unit increase in production. Thus, in the model, the objective function under the real activity will give the marginal cost of producing an extra unit of the activity.

Data Collection

The study region in Northern Alberta is defined as census divisions 10, 12, 13, 14 and 15. The analysis which was completed first covers census division 15. The present analysis involves pooling the data collected from Smoky Lake County, which is part of census division 12, with that for census division 15.

The data for Smoky Lake were obtained from both primary and secondary sources such as the published information on resource availability in that county. The primary data were collected through a questionnaire survey that involved a sample of 35 farmers.

Survey Design

A design is a plan for obtaining and analysing data. The procedure followed in this study began with designing a questionnaire format. The first step was to lay out a general plan to fit in with the required information. The information was aimed at providing an input-output accounting for alfalfa on the basis of a selected plot of ten acres or more. A period of three years was covered starting with the establishment of alfalfa.

When the preliminary format was finished, the questionnaire was tested on five farmers. The procedure was to visit each of the five farmers selected and record the length of time required for each interview, making sure that some of the controversial questions were avoided. For example, a question such as "How much income do you earn?" may hinder the co-operation of the farmers.

During this preliminary survey it was observed that there was difficulty in holding the farmers' attention for more than one hour, and farmers have a good reflexive recall of the various steps they use in their farming operations. It is therefore important to design a questionnaire that will lead the farmer through a chronological order of farm operations for each enterprise.

Selecting the Sample

There are many alternatives in selecting the items which will comprise a sample.[1] Three alternatives were considered in this study:

1. Simple random sample;
2. Systematic sampling; and
3. Stratification.

Simple Random Sample-- A random sample is one in which each individual in the population is equally likely to be sampled. In terms of probability this implies that the probability of any particular member being selected is 1/n, where n denotes the number of individuals in the population. There are several ways to actually carry out the physical process of random sampling:

1. Record each person or name on a slip of paper, mix the slips well in a large container and then draw the number required thoroughly remixing after each individual drawing.

2. Assign each person a number and then draw a random sample of numbers. In other words, a random sample may be obtained by consulting a table of random numbers and reading off a pair of digits for each individual required in the sample.

The main advantage for advocating this method is that random sampling leads to probability models for distributions.

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[1] E.R. Babbie, Survey Research Methods (Belmont: Wadsworth Publishing Company, Inc., 1973).

The importance of this is that conclusions to be drawn about populations through means of a sample are based upon probabilities. The major disadvantage is that the method is physically inconvenient for a large population. For this reason, it is time consuming and therefore costly.

Systematic Sampling-- If one were to draw a 10 percent sample from a list of 730 cards, one might select a random number between 1 and 10, say 4, and pick every 10th card thereafter, i.e., the cards numbered 4, 14, 24 and so on, ending with card numbered 724. A sample of this kind is known as a systematic sample since the choice of the first number, i.e., 4, determines the whole sample.

A systematic sample has the following advantages:

1. The actual selection of a systematic sample is quicker, easier and therefore less expensive than a random sample; and

2. Systematic sampling distributes the sample more evenly over the listed population.

There are two potential disadvantages in systematic sampling:

1. If the population contains a periodic type of variation, and if the interval between successive units in the systematic sample happens to coincide with a multiple of it, one may obtain a sample that is badly biased; and

2. From the results of a systematic sample there is no

reliable method of estimating the standard error of the sample mean.

Stratification--In constructing a valid sampling scheme one has no more than a reliable list of all sampling units in the population, arranged in some recognizable order. But one could use some additional information that might improve on the precision of the random sample estimates. For example, perennial crops can be classified by date of planting, dairy cows by breed. Such information can be used to arrange the units in a grouped or ordered list from which samples may be drawn. A sample of this kind is known as a stratified sample since each population is divided into groups or strata such that 'y' can be expected to be less variable within each stratum over the population as a whole.

Method Applied

The disadvantages and the advantages contained in each of the three alternatives have been noted. The choice of method to use was based on the ability to rectify the disadvantages. For example, the use of a computer can overcome the problem of physical inconvenience characteristic of a simple random sample.

A simple random sample was selected because a computer was to be used. The computer program numbers the elements in the sampling frame. Then it generates its own series of random numbers and prints out the list of elements selected.

Sample Size

The question "How large a sample ought to be taken?" is meaningless on its own according to Sampford. "A sample size appropriate to a given investigation is a compromise between accuracy needed in the results and the cost of obtaining accuracy."[1] The sample size for this study was determined after reviewing expected variance of the variables to be estimated, the cost of sampling and the time available for sampling and data manipulation. The time factor was very important. As such, a sample size of 35 was considered appropriate for the time available.

According to Snedecor: "We want to avoid making the sample so small that the estimate is too inaccurate to be useful. Equally, we want to avoid taking a sample that is more accurate than we require."[2] To this end, a sample size of 35 will probably give a reasonable estimate of the population mean, provided the population is distributed normally. However, the standard error could be higher than with a larger sample size. However, this study is more interested in the population mean than in the sample mean.

Listing the Population

The sampling frame was the list of all farmers in

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[1] M.R. Sampford, An Introduction to Sampling Theory (Edinburgh: Oliver and Boyd, 1956), p. 206.

[2] G.W. Snedecor, Statistical Methods, (Ames: The Iowa State College Press, 1957), p. 501.

Smoky Lake County as obtained from the District Agriculture Office in Smoky Lake. The list was an updated version of the 1973 list as amended by the District Agriculture. The sampling frame contained 779 names from which 40 were selected at random (to provide up to five replacements). The first 35 names constituted the sample. Replacements were used if an interview could not be satisfactorily completed.

The survey was conducted during the last two weeks of August, 1974. The procedure was to call the selected farmer by telephone to explain the need for the survey and to request an interview. In most cases, the meeting followed soon after the telephone conversation. One farmer became hostile when he was visited and was therefore replaced in the sample. This was the only replacement and the survey was completed without any serious problems.

Tabulations and Statistical Analysis

The data collected from the questionnaire survey were compiled for expression in terms of linear programming units. As already stated, the questionnaire format was designed to lead the farmer through a chronological order of farm operations. For example, field operations involved first ploughing, second ploughing, harrowing, seeding, spraying and harvesting (a sample questionnaire is included in the appendices). The time expended on these field operations was recorded in temrs of total tractor hours and total man hours. Then the inforamtion was transfromed into man hours per acre and tractor hours per acre. The same manipulations were done for production expenses such as fertilizer and seed, and return per acre was then calculated.

Further transformations involved the manipulation of the tractor variable cost per acre. This was made possible by the information on tractor variable costs per hour obtained from Farm Machinery Costs issued by the Alberta Department of Agriculture. All the transformations performed from the establishment of alfalfa to the end of three years are contained in the appendices. After transforming data into these units, a statistical analysis was carried out.

The statistical analysis involved the estimation of population parameters such as the mean, standard error, standard deviation and the coefficient of variation. Then tests of significance were done. Tables 25, 26, and 27 show the population parameters, and Tables 28, 29 and 30 show the results of the t-test for kurtosis and skewness on technical coefficients.

The estimation of population parameters serves two purposes: One is concerned with determining whether the estimate is biased and the second is concerned with determining the precision of an estimate. For example, the mean for pounds of nitrogen applied per acre may be of a questionable value. From data compiled, it was found that out of 35 farmers interviewed, only 4 applied fertilizer on establishing alfalfa. It is not surprising that the results of the t-test for kurtosis

TABLE 25

DESCRIPTIVE ANALYSIS: ALFALFA ESTABLISHMENT ACTIVITY, SMOKY LAKE COUNTY,1974

	Mean	Standard Error	Standard Deviation	Coefficient of Variation
Crop Acres	54,171	7.171	42.426	0.783
Man Hours per Acre	2.131	0.131	0.777	0.364
Tractor Hours per Acre	2.029	0.123	0.725	0.357
Tractor Variable Costs per Hour ($)	1.989	0.143	0.846	0.425
Tractor Variable Costs per Acre ($)	3.814	0.264	1.564	0.410
Cost of Seed per Acre ($)	7.744	0.247	1.463	0.188
Pounds of Nitrogen per Acre	5.809	1.456	8.616	1.483
Pounds of Phosphorus per Acre	7.954	2.098	12.414	1.560
Yield of Cover Crop (Equivalent of Bushels of Oats) per Acre	63.878	2.487	14.067	0.220

TABLE 26

DESCRIPTIVE ANALYSIS: MAINTAINING ALFALFA ACTIVITY IN THE SECOND YEAR, SMOKY LAKE COUNTY, 1974

	Mean	Standard Error	Standard Deviation	Coefficient of Variation
Crop Acres	54.171	7.171	42.426	0.783
Man Hours per Acre	1.780	0.140	0.728	0.409
Tractor Hours per Acre	1.652	0.125	0.652	0.394
Tractor Variable Costs per Hour ($)	2.112	0.165	0.857	0.405
Tractor Variable Costs per Acre ($)	3.291	0.309	1.606	0.487
Cost of Twine per Acre ($)	43.037	4.304	22.365	0.519
Pounds of Nitrogen per Acre	2.486	1.278	7.559	3.040
Pounds of Phosphorus per Acre	1.371	1.371	8.113	5.917
Alfalfa Yields (tons) per Acre	1.863	0.056	0.330	0.196

TABLE 27

DESCRIPTIVE ANALYSIS: MAINTAINING ALFALFA ACTIVITY IN THE THIRD YEAR, SMOKY LAKE COUNTY, 1974

	Mean	Standard Error	Standard Deviation	Coefficient of Variation
Crop Acres	54.171	7.171	42.426	0.783
Man Hours per Acre	1.984	0.200	0.957	0.482
Tractor Hours per Acre	1.756	0.193	0.924	0.526
Tractor Variable Costs per Hour ($)	2.148	0.178	0.852	0.396
Tractor Variable Costs per Acre ($)	3.577	0.440	2.110	0.589
Cost of Twine per Acre ($)	56.696	7.164	34.360	0.606
Pounds of Nitrogen per Acre	1.657	0.936	5.536	3.340
Pounds of Phosphorus per Acre	0.571	0.571	3.381	5.921
Alfalfa Yields (tons) per Acre	1.933	0.086	0.493	0.255

TABLE 28

ALFALFA ESTABLISHMENT ACTIVITY: RESULTS OF TESTS FOR KURTOSIS AND SKEWNESS ON TECHNICAL COEFFICIENTS, SMOKY LAKE COUNTY, 1974

			Test Signifiance	
	Kurtosis	Skewness	t-for Kurtosis	t-for Skewness
Crop Acres	1.918	1.541	2.4662*	3.6664*
Man Hours per Acre	-0.494	0.433	-0.6352	1.0302
Tractor Hours per Acre	-0.459	0.429	-0.5902	1.0206
Tractor Variable Costs per Hour	-0.425	0.981	-0.5464	2.3340
Tractor Variable Costs per Acre	0.072	0.535	0.0925	1.2729
Cost of Seed per Acre	0.536	0.282	0.6892	0.6709
Pounds of Nitrogen per Acre	8.470	2.545	10.891*	6.0551*
Pounds of Phosphorus per Acre	0.516	1.355	0.6634	3.2238*
Yield of Cover Crop (Equivalent of Bushels of Oats) per Acre	0.625	1.021	0.8036	2.4292

*t - calculated > t- distribution to an infinite number of degrees of freedom at 2.5 percent level.

TABLE 29

MAINTAINING ALFALFA IN THE SECOND YEAR: RESULTS OF 't' TEST FOR KURTOSIS AND SKEWNESS ON TECHNICAL COEFFICIENTS, SMOKY LAKE COUNTY, 1974

			Test Significance	
	Kurtosis	Skewness	t-for Kurtosis	t-for Skewness
Crop Acres	1.918	1.541	2.4662*	3.6664*
Man Hours per Acre	0.774	0.728	0.9952	1.7320
Tractor Hours per Acre	-0.102	0.408	-0.1311	0.9707
Tractor Variable Costs per Hour	-0.723	0.811	-0.9296	1.9295
Tractor Variable Costs per Acre	5.564	1.995	7.1544*	4.7466*
Cost of Twine per Acre	0.900	0.833	1.1572	1.9819
Pounds of Nitrogen per Acre	9.913	3.187	12.7465*	7.5826*
Pounds of Phosphorous per Acre	35.000	5.916	45.0045*	14.0756*
Alfalfa yields (tons) per Acre	6.359	2.217	8.1766*	5.2748*

* t - calculated > t- distribution to an infinite number of degrees of freedom at 2.5 percent level.

TABLE 30

MAINTAINING ALFALFA IN THE THIRD YEAR: RESULTS OF 't' TEST FOR KURTOSIS AND SKEWNESS ON TECHNICAL COEFFICIENTS, SMOKY LAKE COUNTY, 1974

	Kurtosis	Skewness	Test Significance	
			t-for Kurtosis	t-for Skewness
Crop Acres	1.918	1.541	2.4662	3.6664*
Man Hours per Acre	4.147	1.776	5.3323*	4.2255*
Tractor Hours per Acre	6.076	1.911	7.8127*	4.5467*
Tractor Variable Costs per Hour	-0.666	0.809	-0.8563	1.9248
Tractor Variable Costs per Acre	4.208	1.972	5.4108*	4.6918*
Cost of Twine per Acre	2.689	1.405	3.4576*	3.3428*
Pounds of Nitrogen per Acre	8.770	3.177	11.2768*	7.5588*
Pounds of Phosphorous per Acre	35.000	5.916	45.0045*	14.0756*
Yields of Alfalfa(tons) per Acre	-0.192	0.833	-0.2468	1.9819

* t - calculated > t - distribution to an infinite number of degrees of freedom at 2.5 percent level.

and skewness shows a positive level of significance for nitrogen application. A level or significance for positive skewness dicates an excess in the number of items smaller than the mean. Figure 1 is a histogram showing an example of positive skewness for a frequency distribution of alfalfa acres.

Variability

Variability means the degree to which numerical data tend to spread about an average value. Variability in the size of coefficients of the model in this study may be related to the causes of variation in general.

a) Variation may be due to errors of observation or measurement.

b) Variation may result from rounding figures.

c) Variation may be caused by the restrictions imposed.

d) It is characteristic of large things to vary greatly and small things to vary little.

There is, therefore, an ever present variation, and according to Snedecor: "The facts observed in a sample cannot be taken as facts about the population. Our job then is to reach appropriate conclusions about the population despite sampling variation."[1]

The model is a set of average farm enterprises with probably higher associated variance than would have been the case if the enterprises had been better refined. The result

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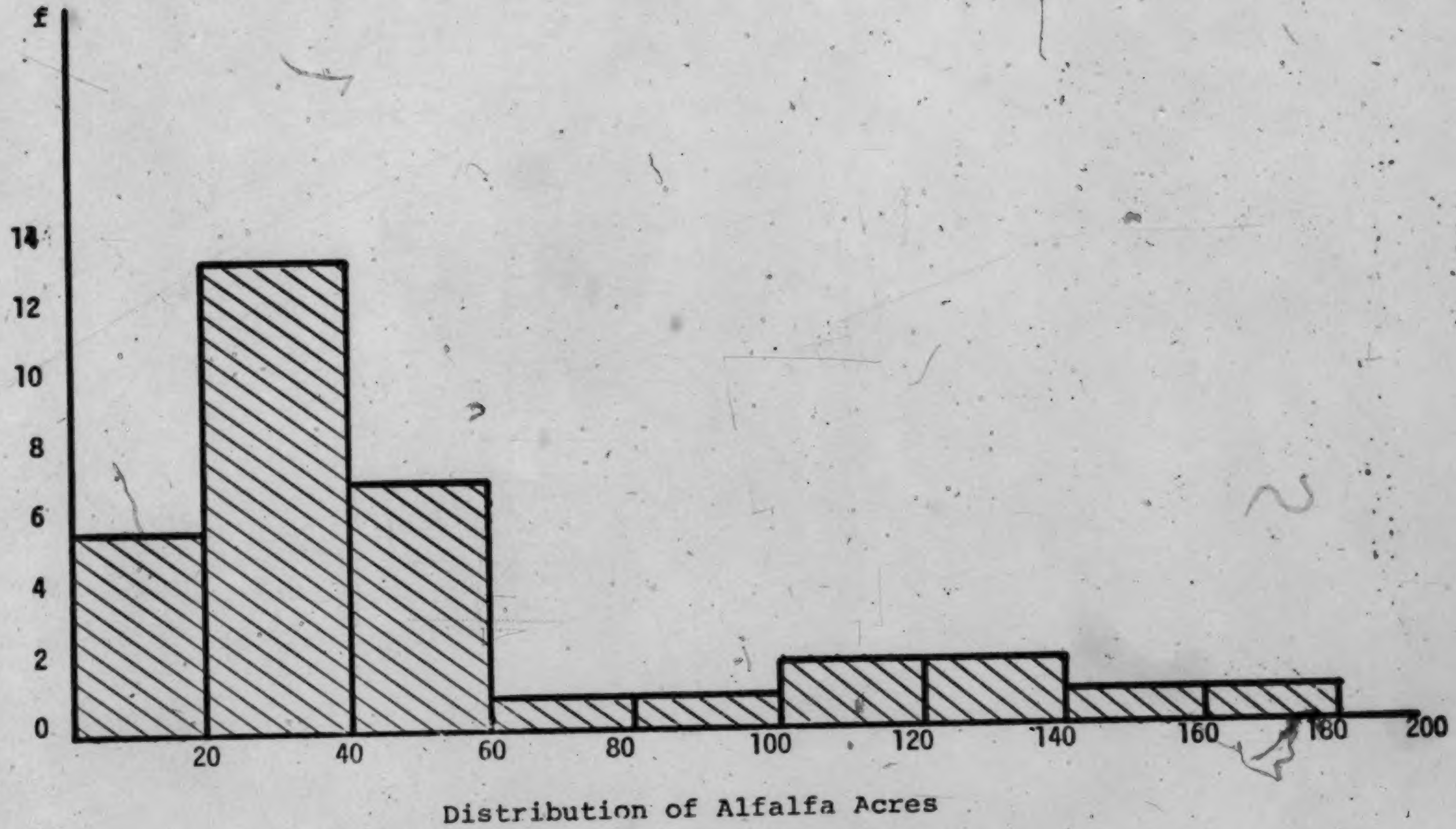
[1] Snedecor, Ibid. pp. 1-2

Figure 7

A HISTOGRAM OF THE FREQUENCY DISTRIBUTION OF ALFALFA ACRES,
SMOKY LAKE COUNTY, 1974



is not as restrictive as may appear on the surface for associated with each coefficient is a measure of the standard deviation, and associated with each enterprise is a definition of the assumptions surrounding that enterprise. For example, referring to cow-calf enterprises, according to Apedaile:

> It would be possible to define three cow-calf enterprises based on the average cow-calf enterprise. The first is the average enterprise and the second and third are derived using the average plus or minus one standard deviation for all coefficients. Since all coefficients do not have the same coefficients of variation, one can expect three different cow-calf enterprises. Variations on this average cow-calf enterprise are possible by adding or subtracting standard deviation to or from the mean coefficients in the base enterprise.[1]

Interpretation of Results

Table 31 indicates the results for the slack activities in the optimum solution. The first column, headed "Number", gives the internal identification of vectors. The second column, headed "Row", identifies the row code as listed in Appendix 7. The third column is headed "AT" and gives the solution according to the following code:

BS ... in the basis and feasible,

FR ... nonbasis, free,

EQ ... nonbasis, artifical or fixed,

UL ... nonbasis, activity at upper limit,

LL ... nonbasis, activity at lower limit.

The fourth column is headed "Activity". This indicates the

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[1] L.P. Apedaile, op. cit., p. 31.

TABLE 31

TECHNOLOGY MODEL FOR NORTHERN ALBERTA: SMOKY LAKE COUNTY ROWS ACTIVITY

```
                                                                                  PAGE     25  -  76/103
           TECH.MODEL N.ALTA

SECTION 1 - ROWS

NUMBER  ...ROW..  AT  ...ACTIVITY...   SLACK ACTIVITY  ..LOWER LIMIT.  ..UPPER LIMIT.  .DUAL ACTIVITY

    1  RCF        BS  3304911.97340-   3304911.97340       NONE            NONE            1.00000
    2  FAL-AC     EQ       .                 .               .               .             8.93648
    3  FAL1+2     UL    18903.00000          .             NONE       16903.00000         48.62764
    4  STUB1+2    UL    53596.00000          .             NONE       53596.00000         19.20051
    5  FAL3       UL    18490.00000          .             NONE       18490.00000         24.46782
    6  STUB3      UL    52425.00000          .             NONE       52425.00000         69.07756
    7  FAL4       UL    23421.00000          .             NONE       23421.00000         28.43393
    8  STUB4      BS       .            66405.00000        NONE       66405.00000           .
    9  R3         BS       .                 .             NONE            NONE              .
   10  R4         BS       .                 .             NONE            NONE              .
   11  R5         BS       .                 .             NONE            NONE              .
   12  R6         BS       .                 .             NONE            NONE              .
   13  R7         BS       .                 .             NONE            NONE              .
   14  ALF3       BS       .                 .             NONE            NONE              .
   15  NT-PAS     UL    59189.00000          .             NONE       59189.00000          1.54200
   16  IP-PAS     UL    22121.00000          .             NONE       22121.00000         33.90643
   17  COM-PAS    BS    46435.20474     68589.79526        NONE      115425.00000            .
   18  P12        BS       .                 .             NONE            NONE              .
   19  LIVSTIME   BS    21747.46600     21747.46600-         .             NONE              .
   20  L-N<A      BS   289110.91240   1265889.08760        NONE     1575000.00000            .
   21  L-M<J      BS   194411.16853    330588.43147        NONE      525000.00000            .
   22  L-J<A      BS   226954.05352    298045.94648        NONE      525000.00000            .
   23  L-S<O      BS   252582.05209    272417.94791        NONE      525000.00000            .
   24  L-TOTL     BS   951631.55002   2198368.44998        NONE     3150000.00000            .
   25  VAL-PRO    BS 12987513.8561-   12987513.8561        NONE            .                 .
   26  C-COST     EQ       .                 .               .               .             1.96538
   27  R21        BS       .                 .             NONE            .                 .
   28  SHORTLIM   UL       .                 .             NONE            .            2000.00000
   29  LGT-EQ     BS       .            46892.00000        NONE       46892.00000            .
   30  HRR-TO     BS       .          5002911.00000        NONE     5002911.00000            .
   31  BORTRANS   BS       .                 .             NONE            .                 .
   32  N-TRAN     EQ       .                 .               .               .             4.35912
   33  R-TRAN     EQ       .                 .               .               .             4.35912
   34  K-TRAN     BS       .                 .               .               .                 .
   35  LTR-SP     EQ       .                 .               .               .             2.84677
   36  MTR-SP     EQ       .                 .               .               .             1.80888
   37  STR-SP     EQ       .                 .               .               .             1.15650
   38  SWA-SP     EQ       .                 .               .               .            15.98342
   39  COM-SP     EQ       .                 .               .               .            43.59115
   40  LTR-PR     BS   197044.69882    277955.30118        NONE      475000.00000            .
   41  MTR-PR     BS   148001.80849    755998.19151        NONE      904000.00000            .
   42  STR-PR     BS    80368.67932    457631.32068        NONE      538000.00000            .
   43  SWA-PR     BS    14865.57262    141134.42738        NONE      156000.00000            .
   44  COM-PR     BS    35710.96076    172289.03924        NONE      208000.00000            .
   45  COMU-IN    UL       .                 .             NONE            .               5.63423
   46  OLY-IN     EQ       .                 .               .               .               5.83032
   47  OAT-IN     EQ       .                 .               .               .               4.38250
   48  RAP-IN     EQ       .                 .               .               .              14.12500
   49  FAL-IN     BS       .                 .               .               .                 .
```

TABLE 31 (con't)

```
                                                                                  PAGE    26  -  76/103
               TECH.MODEL N.ALTA
                                                                             .DUAL ACTIVITY
NUMBER  ...ROW..  AT  ...ACTIVITY...  SLACK ACTIVITY  ..LOWER LIMIT.  ..UPPER LIMIT.
                                                                               9.87301
    50  WHT-IN    EQ        .               .               .               .      50.00000
    51  ALFA-IN   EQ        .               .               .               .      48.00000
    52  ALFA-INP  EQ        .               .               .               .        .65207
    53  HAY-IN    EQ        .               .               .               .       4.50738
    54  NT-P-IN   EQ        .               .               .               .      41.73504
    55  TA-P-IN   EQ        .               .               .               .       3.81728
    56  GRNFD-IN  EQ        .               .               .               .       2.62422
    57  STR-IN    EQ        .               .               .               .         .
    58  COP-IN    BS        .               .               .               .      24.37546
    59  BLY-SD    EQ        .               .               .               .      19.48258
    60  OAT-SD    EQ        .               .               .               .      62.83650
    61  RAP-SD    EQ        .               .               .               .      28.64562
    62  WHT-SD    EQ        .               .               .               .        .16013-
    63  GRN-ST    EQ        .               .               .               .        .07413-
    64  HAY-ST    EQ        .               .               .             NONE        .
    65  BULLINV   BS    966.18249       966.18249-     23062.00000        NONE     183.17672-
    66  COWINV    LL  23062.00000           .               .             NONE        .
    67  RPCINV    BS   2167.82800      2167.82800-          .               .     145.93117
    68  WCOW-TR   EQ        .               .               .               .     150.00000
    69  WCULCWSL  EQ        .               .               .             NONE        .
    70  WCAFINV   BS        .               .               .               .      65.89577
    71  WCAF-TR   EQ        .               .               .               .     100.00000
    72  SYG-1VAD  EQ        .               .               .               .     125.00000
    73  SYG-2VAD  EQ        .               .               .               .     150.00000
    74  SYG-3VAD  EQ        .               .               .               .     100.00000
    75  SYG-1SL   EQ        .               .               .               .     125.00000
    76  SYG-2SL   EQ        .               .               .               .     150.00000
    77  SYG-3SL   EQ        .               .             NONE              .      30.14650
    78  WFDRINV   UL        .               .               .               .     121.49308
    79  WFDR-TR   EQ        .               .               .               .     250.00000
    80  FATBEEF   EQ        .               .               .               .     150.00000
    81  SCULCWSL  EQ        .               .               .               .     200.00000
    82  BULL-TR   EQ        .               .               .               .     190.00000
    83  SCOWINV   EQ        .               .               .               .      50.00000
    84  SCAFVAD   EQ        .               .               .               .      50.00000
    85  SCAFSL    EQ        .               .               .               .     200.00000
    86  SFDR-SL   EQ        .               .               .               .     150.00000
    87  RPCSL     EQ        .               .               .               .      50.00000
    88  WCAF-1SL  EQ        .               .               .               .      65.00000
    89  WCAF-2SL  EQ        .               .               .               .      80.00000
    90  WCAF-3SL  EQ        .         28893.00000         NONE        28893.00000     .
    91  STW-UN    BS        .          6571.00000         NONE         6571.00000     .
    92  SOW-PP    BS        .               .               .               .      23.85000
    93  C-SW-T    EQ        .               .               .               .      65.25000
    94  WSNP-T    EQ        .               .               .               .      45.61683
    95  HOG-TR    EQ        .               .               .               .      12.50000
    96  BOR-TR    EQ        .               .               .               .      11.24065-
    97  ALF.HAL1  EQ        .               .               .               .      12.65967
    98  ALF.PAL2  EQ        .               .
```

amount of resource used or required. The fifth column is headed "Slack Activity" and indicates the amount of resource unused, or the requirement overfulfilled if the row has one sign throughout. The sixth column is headed "Lower Limit". This is the lower limit for a "greater than" requirement or equality constraint. The seventh column is headed "Upper Limit" and indicates the limit of resources available for a "less than" or equality constraint. The eighth column is headed "Dual Activity" and is the shadow price or marginal value product associated with a one unit reduction in resource availability.

The results (Table 31) indicate that stubble and fallow land of classes 1, 2 and 3 is limiting at upper boundaries except stubble land on soil class 4. The same situation holds for natural pasture and improved pasture. On the other hand, labour use is in excess supply, indicated by the presence of very large amounts of slack activity in the labour constraints. As a result, labour use has a shadow price of zero. The same interpretation is extended to the equipment constraints.

Table 32 indicates the results for the column activities in the optimal solution and has a format similar to the row section. The first column is an internal identification. The second column, headed "Column" is the coded identification. The third column, "AT" identifies the status of activities in the solution and uses the same status codes as those in the "Row" section. The fourth column, "Activity", is the level at

TABLE 32

TECHNOLOGY MODEL FOR NORTHERN ALBERTA: SMOKY LAKE COLUMN ACTIVITIES

```
            TECH.MODEL N.ALTA                                                                    PAGE    27  -  76/103

SECTION 2 - COLUMNS

 NUMBER  .COLUMN.  AT  ...ACTIVITY...  ..INPUT COST..  ..LOWER LIMIT.  ..UPPER LIMIT.  .REDUCED COST.

     99  BLY1+2F   LL         .            1.74000           .              NONE          7.18527
    100  BLY1+2S   BS       64.64348       1.74000           .              NONE           .
    101  BLY3F     LL         .            1.74000           .              NONE           .54693
    102  BLY3S     LL         .            1.74000           .              NONE         60.08340
    103  BLY4F     LL         .            1.74000           .              NONE         12.71711
    104  BLY4S     LL         .            1.74000           .              NONE          4.61429
    105  OAT1+2F   LL         .            3.11000           .              NONE         17.65969
    106  OAT1+2S   BS    17375.28392       3.11000           .              NONE           .
    107  OAT3F     LL         .            3.11000           .              NONE          6.58982
    108  OAT3S     LL         .            3.11000           .              NONE         59.16627
    109  OAT4F     BS    27421.20000       3.11000           .              NONE           .
    110  OAT4S     LL         .            3.11000           .              NONE          6.26038
    111  RAP1+2F   BS    18903.20000       2.12000           .              NONE           .
    112  RAP1+2S   BS    36156.07260       2.12000           .              NONE           .
    113  RAP3F     BS    18499.00000       2.12000           .              NONE           .
    114  RAP3S     LL         .            2.12000           .              NONE         64.67982
    115  RAP4F     LL         .            2.12000           .              NONE         14.99835
    116  RAP4S     LL         .            2.12000           .              NONE         14.31518
    117  FAL-PN    BS    12327.38300       2.14000           .              NONE           .
    118  WHT1+2F   LL         .            2.30000           .              NONE          4.06022
    119  WHT1+2S   BS         .            2.30000           .              NONE           .
    120  WHT3F     LL         .            2.30000           .              NONE          7.29133
    121  WHT3S     LL         .            2.30000           .              NONE         63.86361
    122  WHT4F     LL         .            2.30000           .              NONE         42.33667
    123  WHT4S     LL         .            2.30000           .              NONE         20.42805
    124  A.EST-1   LL         .            2.59000           .              NONE        108.19382
    125  A.PR-1    BS         .            1.56000           .              NONE           .
    126  ALFA-SL   BS         .           50.00000-          .              NONE           .
    127  A.EST-2   BS     1885.67416       2.59000           .              NONE           .
    128  A.PR-2    BS     9428.37079        .                .              NONE           .
    129  ALFA-SP   BS    17253.91854      48.00000-          .              NONE           .
    130  N-FERT    BS     3415.29300      29.40000           .              NONE           .
    131  P-FERT    BS    11977.81415      29.40000           .              NONE           .
    132  K-FERT    LL         .           36.60000           .              NONE        108.53308
    133  LTR-SR    BS   197820.31882        .26000           .              NONE           .
    134  HTR-SR    BS   151471.44894        .61000           .              NONE           .
    135  STR-SR    BS    80368.67932        .39000           .              NONE           .
    136  SWA-SR    BS    14865.57262       5.39000           .              NONE           .
    137  COM-SR    BS    35710.96076      14.70000           .              NONE           .
    138  LTR-PR    LL         .          180.00000           .              NONE       3717.69231
    139  HTR-PR    LL         .          140.00000           .              NONE       2891.53846
    140  STR-PR    LL         .           80.00000           .              NONE       1652.30769
    141  SWA-PR    LL         .           80.00000           .              NONE       1652.30769
    142  COM-PR    LL         .          200.00000           .              NONE       4130.76923
    143  BRY-SL    LL         .          109.54000-          .              NONE          7.02642
    144  OAT-SL    BS    34306.36272      87.45000-          .              NONE           .
    145  RAP-SL    BS    29656.33122     292.52000-          .              NONE           .
    146  WHT-SL    LL         .          129.28000-          .              NONE         68.18028
    147  STR-GP    BS    62276.69366       1.38000           .              NONE           .
```

TABLE 32 (con't)

```
                                                                                         PAGE    28  -  76/163
              TECH.MODEL N.ALTA

NUMBER  .COLUMN.  AT  ...ACTIVITY...  ..INPUT COST..  ..LOWER LIMIT.  ..UPPER LIMIT.  .REDUCED COST.

  148   STP-HY    BS  101530.45500        .50000           .             NONE             .
  149   SHY-SD    BS      51.71475       8.22000           .             NONE             .
  150   OAT-SD    BS   33452.95281       6.57000           .             NONE             .
  151   RAP-SP    BS   59839.25838      21.19000           .             NONE             .
  152   WHT-SP    BS        .            5.66000           .             NONE             .
  153   WCOW-1    BS   23062.00000      30.00000           .             NONE             .
  154   WCOW-2    LL        .           30.45000           .             NONE            6.07901
  155   WCOW-3    LL        .           32.89000           .             NONE           33.54576
  156   WCAF-1    LL        .           25.00000           .             NONE          205.24062
  157   WCAF-2    LL        .           27.30000           .             NONE          216.10812
  158   WCAF-3    LL        .           29.00000           .             NONE          251.07966
  159   WFDR-1    LL        .           30.00000           .             NONE           95.76269
  160   WFDR-2    BS        .           32.00000           .             NONE             .
  161   WFDR-3    LL        .           34.00000           .             NONE           27.25389
  162   SCOW-1    BS   13654.93827       5.77600           .             NONE             .
  163   SCOW-2    BS    3945.93333       5.77600           .             NONE             .
  164   SCOW-3    BS    3865.85040       5.77600           .             NONE             .
  165   SYLG-1    LL        .            3.00000           .             NONE           42.70868
  166   SYLG-2    LL        .            3.00000           .             NONE           23.12315
  167   SYLG-3    BS        .            3.00000           .             NONE             .
  168   SFDR-1    BS        .            3.00000           .             NONE             .
  169   WCULCWSL  BS    1591.27800     150.00000-          .             NONE             .
  170   SYG-1VAD  BS        .          150.00000-          .             NONE             .
  171   SYG-2VAD  BS        .          125.00000-          .             NONE             .
  172   SYG-3VAD  BS        .          150.00000-          .             NONE             .
  173   SYG-1SL   BS        .          110.00000-          .             NONE             .
  174   SYG-2SL   BS        .          125.00000-          .             NONE             .
  175   SYG-3SL   BS        .          150.00000-          .             NONE             .
  176   FATCWFSL  BS        .          250.00000-          .             NONE             .
  177   SCULCWSL  BS    1953.33570     150.00000-          .             NONE             .
  178   BULLSL    BS     107.35361     200.00000-          .             NONE             .
  179   SCOWVAD   BS   19495.41558     190.00000-          .             NONE             .
  180   SCAFVAD   BS   14750.38601      50.00000-          .             NONE             .
  181   SCAFSL    BS    3929.14213      50.00000-          .             NONE             .
  182   SFDR-1SL  BS        .          200.00000-          .             NONE             .
  183   WPCSL     BS     184.49600     150.00000-          .             NONE             .
  184   WCAF-1SL  BS        .           50.00000-          .             NONE             .
  185   WCAF-2SL  BS        .           65.00000-          .             NONE             .
  186   WCAF-3SL  BS        .           80.00000-          .             NONE             .
  187  *B-CASH    BS    4579.84766      44.30000           .             NONE             .
  188   H-LONG    LL        .           70.00000           .             NONE          207.57692
  189   LGT-GAL   BS    9159.69531    1000.00000           .             NONE             .
  190   SOW-UN    BS        .           71.17000           .             NONE             .
  191   SOW-BT    LL        .           18.93000           .             NONE           97.25058
  192   BOR-BT    LL        .           42.09000           .             NONE          195.01642
  193   WIN-SD    BS        .           65.25000-          .             NONE             .
  194   HOG-SD    LL        .           43.50000-          .             NONE            2.11683
  195   CSOW-S    BS        .           23.85000-          .             NONE             .
  196   BOR-SD    BS        .           12.50000-          .             NONE             .
  197   HAY-PN    BS   79471.79309       3.25000           .             NONE             .
  198   P-Y-PN    BS   22121.00000       2.64000           .             NONE             .
```

TABLE 32 (con't)

```
                                                                        PAGE    20  -  76/103
        TECH.MODEL N.ALTA

NUMBER  .COLUMN.  AT  ...ACTIVITY...  ..INPUT COST..  ..LOWER LIMIT.  ..UPPER LIMIT.  .REDUCED COST.
                                                                          NONE            .
   199  P-N-PH    BS    59139.00000        1.00000           .            NONE       103.13639
   200  HAY-PR    LL          .           35.00000           .            NONE            .
   201  COMPAS    BS    46438.20474        1.90000           .            NONE            .
   202  GRNFEED   BS    41110.95566        8.25000           .
```

which that activity enters the solution, and is expressed in the same units as the input data. The fifth column, "Input Cost", gives the value of that activity in the objective function. Columns six and seven give the "Lower Limit" and "Upper Limit" for each activity. The eighth column, "Reduced Cost", is the change in the value of the objective function for activities not in the optimal solution that would result if one unit of the activity were forced into the solution. Alternatively, it may be considered the amount of change required in the objective function to bring the activity into the optimal solution.

The activity levels (Table 32) show alfalfa, barley, oats, fallow and rape as the only cropping activities. These activities are tied mainly to the relative selling price and to the coefficients generated to simulate cost of production and yields. Given the selling prices used in the model, the results are realistic, but if the selling price were reduced or increased for the other cropping activities, the results could change considerably. For example, wheat is not in the solution and under the reduced cost column, we find that forcing wheat activity on stubble land of class 3 would decrease the value of the objective function by $45.83 for each acre of wheat.

Table 33 shows rows at limit level. The first five columns are the same as for Table 31. The sixth column shows the "Lower Constraint Limit" (lower limit) and "Upper Constraint Limit"

TABLE 33

TECHNOLOGY MODEL FOR NORTHERN ALBERTA: SENSITIVITY ANALYSIS ROWS AT LIMIT LEVEL.

```
              TECH.MODEL N.ALTA                                                                           PAGE    32  -  76/183

     SECTION 1 - ROWS AT LIMIT LEVEL

 NUMBER  ...ROW..  AT  ...ACTIVITY...  SLACK ACTIVITY  ..LOWER LIMIT.  LOWER ACTIVITY  ...UNIT COST..  ..UPPER COST..  LIMITING  AT
                                                       ..UPPER LIMIT.  UPPER ACTIVITY  ...UNIT COST..  ..LOWER COST..  PROCESS.  AT

      2  FAL-AC    EQ         .               .               .        305445.31250-         8.93648                  LTR-PR    LL
                                                              .         12327.07812          8.93648-                 FAL-FN    LL

      3  FAL1+2    UL    18903.00000          .             NONE              .             48.62704                  RAP1+2F   LL
                                                         18903.00000   394518.18750         48.62704-                 LTR-FR    LL

      4  STUB1+2   UL    53596.00000          .             NONE        17439.92969         19.20050                  RAP1+2S   LL
                                                         53596.00000   334557.56250         19.20050-                 LTR-PR    LL

      5  FAL3      UL    18490.00000          .             NONE              .             24.46782                  RAP3F     LL
                                                         18490.00000   374842.87500         24.46782-                 LTR-PR    LL

      6  STUB3     UL    52425.00000          .             NONE        41110.96094         69.07756                  A.PR-2    LL
                                                         52425.00000  1149410.00000         69.07756-                 L-SCO     LL

      7  FAL4      UL    23421.00000          .             NONE              .             28.43391                  OAT4F     LL
                                                         23421.00000    40796.28125         28.43391-                 OAT1+2S   LL

     15  NT-PAS    UL    59189.00000          .             NONE              .              1.54200                  P-N-FN    LL
                                                         59189.00000   117236.75391          1.54200-                 COMPAS    LL

     16  IP-PAS    UL    22121.00000          .             NONE        12807.38672         33.90642                  COV-PAS   LL
                                                         22121.00000    28390.15625         33.90642-                 COMPAS    LL

     26  C-COST    EQ         .               .               .          INFINITY-           1.96538                      NONE
                                                              .       4763041.00000          1.96538-                 LGT-BAL   LL

     29  SHORTLIM  UL         .               .             NONE         INFINITY-        2000.00000                      NONE
                                                              .          4579.84766       2000.00000-                 LGT-BAL   LL

     32  N-TRAN    EQ         .               .               .          INFINITY-           4.35911                      NONE
                                                              .         68305.81250          4.35911-                 N-FERT    LL

     33  P-TRAN    EQ         .               .               .          INFINITY-           4.35911                      NONE
                                                              .        239556.25000          4.35911-                 P-FERT    LL

     35  LTR-SP    EQ         .               .               .          INFINITY-           2.84677                      NONE
                                                              .        197800.81250          2.84677-                 LTR-SR    LL

     36  MTR-SP    EQ         .               .               .          INFINITY-           1.80888                      NONE
                                                              .        151471.43750          1.80888-                 MTR-SR    LL

     37  STR-SP    EQ         .               .               .          INFINITY-           1.15650                      NONE
                                                              .         80360.62500          1.15650-                 STR-SR    LL

     39  SWA-SP    EQ         .               .               .          INFINITY-          15.98342                      NONE
                                                              .         14865.57031         15.98342-                 SWA-SR    LL
```

TABLE 33 (Con't)

```
                                                                                              PAGE     33  -  76/103
           TECH.MODEL N.ALTA
NUMBER  ...ROW..  AT  ...ACTIVITY...  SLACK ACTIVITY  ..LOWER LIMIT.  LOWER ACTIVITY  ...UNIT COST..  ..UPPER COST..  LIMITING  AT
                                                      ..UPPER LIMIT.  UPPER ACTIVITY  ...UNIT COST..  ..LOWER COST..  PROCESS.  AT

                                                                        INFINITY-        43.59114                        NONE
   39  COW-SP    EQ        .               .               .          35710.95703       43.59114-                     COW-SP    LL
                                                           .
                                                                      68985.75000-       5.63423                      COW-PAS   LL
   45  COWU-IN   UL        .               .             NONE         46438.20313        5.63423-                     COWPAS    LL
                                                           .
                                                                     568666.25000-       5.83032                      RAP1+2S   LL
   46  BLY-IN    EQ        .               .               .            853.29395        5.83032-                     BLY1+2S   LL
                                                           .
                                                                     686127.18750-       4.38250                      CAT-SL    LL
   47  OAT-IN    EQ        .               .               .          INFINITY           4.38250-                       NONE
                                                           .
                                                                     592920.50000-      14.12500                      RAP-SL    LL
   48  RAP-IN    EQ        .               .               .          INFINITY          14.12500-                       NONE
                                                           .
                                                                     165830.81250-       9.87301                      CAT1+2S   LL
   50  WHT-IN    EQ        .               .               .               .             9.87301-                     WHT1+2S   LL
                                                           .
                                                                           .            50.00000                      ALFA-SL   LL
   51  ALFA-IN   EQ        .               .               .          INFINITY          50.00000-                       NONE
                                                           .
                                                                      17253.91797-      47.99998                      ALFA-SP   LL
   52  ALFA-INP  EQ        .               .               .          INFINITY          47.99998-                       NONE
                                                           .
                                                                    3631193.00000-        .65207                      L-JCA     LL
   53  HAY-IN    EQ        .               .               .        1720886.00000         .65207-                     HAY-PN    LL
                                                           .
                                                                      59188.99609-       4.50738                      SCOW-2    LL
   54  NT-P-IN   EQ        .               .               .          58047.75391        4.50738-                     COMPAS    LL
                                                           .
                                                                       9313.61328-      41.73503                      COW-PAS   LL
   55  TA-P-IN   EQ        .               .               .           6269.15625       41.73503-                     COMPAS    LL
                                                           .
                                                                     261836.87500-       3.81728                      A.PR-2    LL
   56  GRNFD-IN  EQ        .               .               .         551307.50000        3.81728-                     GRNFEED   LL
                                                           .
                                                                     274424.56250-       2.62422                      RAP1+2S   LL
   57  STR-IN    EQ        .               .               .         131878.37500        2.62422-                     OAT1+2S   LL
                                                           .
                                                                        INFINITY-       24.37546                        NONE
   59  BLY-SD    EQ        .               .               .             51.71478       24.37546-                     DRY-SD    LL
                                                           .
                                                                        INFINITY-       19.48257                        NONE
   60  OAT-SD    EQ        .               .               .          33452.94922       19.48257-                     CAT-SD    LL
                                                           .
                                                                        INFINITY-       62.83649                        NONE
   61  RAP-SD    EQ        .               .               .          58839.25781       62.83649-                     RAP-SP    LL
                                                           .
                                                                        INFINITY-       28.64561                        NONE
   62  WHT-SD    EQ        .               .               .               .            28.64561-                     WHT-SP    LL
                                                           .
```

TABLE 33 (con't)

```
           TECH.MODEL N.ALTA                                                                                           PAGE    34  -  76/1C3

NUMBER ...ROW.. AT  ...ACTIVITY...  SLACK ACTIVITY  ..LOWER LIMIT.  LOWER ACTIVITY  ...UNIT COST..  ..UPPER COST..  LIMITING  AT
                                                    ..UPPER LIMIT.  UPPER ACTIVITY  ...UNIT COST..  ..LOWER COST..  PROCESS.  AT

    63 GRN-ST   EQ        .              .                .         1245533.00000-        .16013-                   STR-GR    LL
                                                          .             INFINITY          .16013                      NONE

    64 HAY-ST   EQ        .              .                .         2036609.00000-        .07413-                   STR-HY    LL
                                                          .             INFINITY          .07413                      NONE

    65 COWINV   LL   23062.00000         .          23062.00000       18995.34375      183.17671-                   CCWPAS    LL
                                                           NONE       29237.23438      183.17671                    COW-PAS   LL

    66 WCOW-TR  EQ        .              .                .            3869.85034-     145.93117                    CCWPAS    LL
                                                          .            5749.14453      145.93117-                   COW-PAS   LL

    69 WCULCWSL EQ        .              .                .            1591.27783-     150.00000                    WCULCWSL  LL
                                                          .             INFINITY       150.00000-                     NONE

    71 WCAF-TR  EQ        .              .                .                 .           85.89577                    SYLG-3    LL
                                                          .            7665.52734       85.89577-                   CCW-PAS   LL

    72 SYG-1VAD EQ        .              .                .                 .           99.99998                    SYG-1VAD  LL
                                                          .             INFINITY        99.99998-                     NONE

    73 SYG-2VAD EQ        .              .                .                 .          125.00000                    SYG-2VAD  LL
                                                          .             INFINITY       125.00000-                     NONE

    74 SYG-3VAD EQ        .              .                .                 .          150.00000                    SYG-3VAD  LL
                                                          .             INFINITY       150.00000-                     NONE

    75 SYG-1SL  EQ        .              .                .                 .          100.00000                    SYG-1SL   LL
                                                          .             INFINITY       100.00000-                     NONE

    76 SYG-2SL  EQ        .              .                .                 .          125.00000                    SYG-2SL   LL
                                                          .             INFINITY       125.00000-                     NONE

    77 SYG-3SL  EQ        .              .                .                 .          150.00000                    SYG-3SL   LL
                                                          .             INFINITY       150.00000-                     NONE

    78 WFDRINV  UL        .              .               NONE               .           30.14650                    WFDR-2    LL
                                                          .           17498.89062       30.14650-                   RAF1+2S   LL

    79 WFDR-TR  EQ        .              .                .                 .          121.49307                    SFDR-1    LL
                                                          .            3945.93311      121.49307-                   SCOW-2    LL

    80 FATBEEF  EQ        .              .                .                 .          249.99998                    FATBEFSL  LL
                                                          .             INFINITY       249.99998-                     NONE

    81 SCULCWSL EQ        .              .                .            1953.83569-     150.00000                    SCULCWSL  LL
                                                          .             INFINITY       150.00000-                     NONE

    82 BULL-TR  EQ        .              .                .             107.35361-     199.99998                    BULLSL    LL
                                                          .             INFINITY       199.99998-                     NONE
```

TABLE 33 (con't)

```
            TECH.MODEL N.ALTA                                                                     PAGE    35  -  76/163

 NUMBER  ...ROW..   AT   ...ACTIVITY...  SLACK ACTIVITY  ..LOWER LIMIT.  LOWER ACTIVITY  ...UNIT COST..  ..UPPER COST..  LIMITING   AT
                                                         ..UPPER LIMIT.  UPPER ACTIVITY  ...UNIT COST..  ..LOWER COST..  PROCESS.   AT

     83  SCOWINV    EQ           .               .              .         19495.41466-       190.00000                  SCOWVAD    LL
                                                                .           INFINITY         190.00000-                    NONE

     84  SCAFVAD    EQ           .               .              .         14750.38281-        50.00000                  SCAFVAD    LL
                                                                .           INFINITY          50.00000-                    NONE

     85  SCAFSL     EQ           .               .              .          3929.14209-        50.00000                  SCAFSL     LL
                                                                .           INFINITY          50.00000-                    NONE

     86  SFOR-SL    EQ           .               .              .               .            199.99998                  SFOR-1SL   LL
                                                                .           INFINITY         199.99998-                    NONE

     87  SPCSL      EQ           .               .              .           184.49595-       150.00000                  RPCSL      LL
                                                                .           INFINITY         150.00000-                    NONE

     88  WCAF-1SL   EQ           .               .              .               .             49.99998                  WCAF-1SL   LL
                                                                .           INFINITY          49.99998-                    NONE

     89  WCAF-2SL   EQ           .               .              .               .             65.00000                  WCAF-2SL   LL
                                                                .           INFINITY          65.00000-                    NONE

     90  WCAF-3SL   EQ           .               .              .               .             79.99998                  WCAF-3SL   LL
                                                                .           INFINITY          79.99998-                    NONE

     93  C-SW-T     EQ           .               .              .               .             23.84999                  CSCW-S     LL
                                                                .           INFINITY          23.84999-                    NONE

     94  WENP-T     EQ           .               .              .               .             65.25000                  WEN-SD     LL
                                                                .           INFINITY          65.25000-                    NONE

     95  HOG-TR     EQ           .               .              .        109981.12500-        45.61682                  RAP1+2S    LL
                                                                .               .             45.61682-                 SCW-LN     LL

     96  BOR-TR     EQ           .               .              .               .             12.50000                  BOR-SD     LL
                                                                .           INFINITY          12.50000-                    NONE

     97  ALF.BAL1   EQ           .               .              .               .             11.24065-                 ALFA-SL    LL
                                                                .         11314.03906         11.24065                  A.PR-2     LL

     98  ALF.BAL2   EQ           .               .              .         56570.20313-        12.65967                  A.PR-2     LL
                                                                .         11314.04297         12.65967-                 A.EST-2    LL
```

(upper limit) for each row. The seventh column, "Lower Activity", gives the lower limit to which resources may be decreased at a reduction in profit per unit, given by the corresponding "Unit Cost" of column eight. Below this limit, the change in gross farm income per unit of resource (shadow price) will change. The tenth column shows the "Limiting Process" which identifies the row or column that would change if the limits of change shown under lower activity or upper activity are exceeded. Column eleven, "AT", shows the status of the limiting process column or row if the lower activity or upper activity limits of change are exceeded.

Table 34 shows columns at limit level. "Lower Limit" in column six is the specific lower limit, and where no limit is specified, an implied limit of zero is assumed. "Upper Limit", again in column six, is the upper limit for the activity. The nineth column, "Upper Cost", shows the highest cost for inputs or lowest price for output that will permit the activity to be maintained at its present level and status in the optimal solution. "Lower Cost" is the lowest cost or highest price that will permit the activity to maintain its present level status in the optimal solution.

Tables 35 and 36 show the rows and columns at intermediate level. These are interpreted in the same way as the rows and columns at limit level. The significance of these rows and columns at intermediate level is that they provide a comparison between upper and lower limit activities within a range of prices. The reasons for these limiting activities may not always

TABLE 34: TECHNOLOGY MODEL FOR NORTHERN ALBERTA: SENSITIVITY ANALYSIS COLUMNS AT LIMIT LEVEL

```
                                                                                                      PAGE    36  -  76/103
              TECH.MODEL N.ALTA

   SECTION 2 - COLUMNS AT LIMIT LEVEL

 NUMBER  .COLUMN.  AT  ...ACTIVITY...  ..INPUT COST..  ..LOWER LIMIT.  LOWER ACTIVITY  ...UNIT COST..  ..UPPER COST..  LIMITING  AT
                                                       ..UPPER LIMIT.  UPPER ACTIVITY  ...UNIT COST..  ..LOWER COST..  PROCESS.  AT

     99  BLY1+2F   LL         .           1.74000            .         29482.75000-        7.18527-        INFINITY    RAP1+2S   LL
                                                           NONE            50.91252        7.18527         5.44527-    BLY1+2S   LL

    101  BLY3F     LL         .           1.74000            .         35106.97266-         .54693-        INFINITY    RAP1+2S   LL
                                                           NONE            62.42091         .54693         1.19307     BLY1+2S   LL

    102  BLY3S     LL         .           1.74000            .           474.05200-       60.08339-        INFINITY    BRY-SD    LL
                                                           NONE            74.85034       60.08339        58.34339-    BLY1+2S   LL

    103  BLY4F     LL         .           1.74000            .           948.10425-       12.71711-        INFINITY    BRY-SD    LL
                                                           NONE            69.37347       12.71711        10.97711-    BLY1+2S   LL

    104  BLY4S     LL         .           1.74000            .           203.16521-        4.61429-        INFINITY    BRY-SD    LL
                                                           NONE            94.81042        4.61429         2.87429-    BLY1+2S   LL

    105  OAT1+2F   LL         .           3.11000            .         36156.07031-       17.65968-        INFINITY    RAP1+2S   LL
                                                           NONE         17375.28125       17.65968        14.54968-    OAT1+2S   LL

    107  OAT3F     LL         .           3.11000            .         36156.07031-        6.58982-        INFINITY    RAP1+2S   LL
                                                           NONE         17375.28125        6.58982         3.47982-    OAT1+2S   LL

    108  OAT3S     LL         .           3.11000            .         36156.07031-       59.16626-        INFINITY    RAP1+2S   LL
                                                           NONE         11314.03906       59.16626        56.05626-    A.PR-2    LL

    110  OAT4S     LL         .           3.11000            .         36156.07031-        6.26038-        INFINITY    RAP1+2S   LL
                                                           NONE         17375.28125        6.26038         3.15038-    OAT1+2S   LL

    114  RAP3S     LL         .           2.12000            .         53595.98828-       64.67981-        INFINITY    FAL-FN    LL
                                                           NONE         11314.03906       64.67981        62.55981-    A.PR-2    LL

    115  RAP4F     LL         .           2.12000            .         17375.28125-       14.99835-        INFINITY    OAT1+2S   LL
                                                           NONE         23420.99609       14.99835        12.87835-    OAT4F     LL

    116  RAP4S     LL         .           2.12000            .         53595.98828-       14.31518-        INFINITY    FAL-FN    LL
                                                           NONE         66405.00000       14.31518        12.19518-    STUB4     LL

    118  WHT1+2F   LL         .           2.30000            .         39259.59375-        4.06022-        INFINITY    RAP1+2S   LL
                                                           NONE                 .          4.06022         1.76022-    WHT1+2S   LL

    120  WHT3F     LL         .           2.30000            .                 .           7.29133-        INFINITY    WHT-SP    LL
                                                           NONE                 .          7.29133         4.99133-    WHT1+2S   LL

    121  WHT3S     LL         .           2.30000            .                 .          63.86360-        INFINITY    WHT-SP    LL
                                                           NONE                 .         63.86360        61.56360-    WHT1+2S   LL

    122  WHT4F     LL         .           2.30000            .                 .          42.33865-        INFINITY    WHT-SP    LL
                                                           NONE                 .         42.33865        40.03865-    WHT1+2S   LL
```

TABLE 34 (con't)

```
         TECH.MODEL N.ALTA                                                                          PAGE     37  -  76/1C3

NUMBER  .COLUMN.  AT  ...ACTIVITY...  ..INPUT COST..  ..LOWER LIMIT.  LOWER ACTIVITY  ...UNIT COST..  ..UPPER COST..  LIMITING  AT
                                                      ..UPPER LIMIT.  UPPER ACTIVITY  ...UNIT COST..  ..LOWER COST..  PROCESS.  AT

   123  WHTAS     LL        .             2.30000           .               .           20.42804-        INFINITY     WHT-SP    LL
                                                           NONE             .           20.42804         18.12804-    WHT1+25   LL

   124  A.EST-1   LL        .             2.59000           .               .          108.19382-        INFINITY     ALFA-SL   LL
                                                           NONE        1885.67334      108.19382        105.60382-    A.PR-2    LL

   132  K-FERT    LL        .            36.59999           .               .          108.53307-        INFINITY     K-TRAN    LL
                                                           NONE             .          108.53307         71.93307-    K-TRAN    LL

   138  LTR-PR    LL        .           180.00000           .          277.95508-     3717.69214-        INFINITY     LTR-PR    UL
                                                           NONE             .         3717.69214       3537.69214-    BCRTRANS  LL

   139  MTR-PR    LL        .           140.00000           .          755.99805-     2891.53833-        INFINITY     MTR-PR    UL
                                                           NONE             .         2891.53833       2751.53833-    ECRTRANS  LL

   140  STR-PR    LL        .            80.00000           .          457.63110-     1652.30762-        INFINITY     STR-PR    LL
                                                           NONE             .         1652.30762       1572.30762-    EORTRANS  UL

   141  SWA-PR    LL        .            80.00000           .          352.83594-     1652.30762-        INFINITY     SWA-PR    LL
                                                           NONE             .         1652.30762       1572.30762-    BCRTRANS  LL

   142  CON-PR    LL        .           200.00000           .          430.72241-     4130.76563-        INFINITY     CCW-PR    UL
                                                           NONE             .         4130.76563       3930.76562-    BCRTRANS  LL

   143  BRY-SL    LL        .           109.57999-          .           42.66469-        7.02642-        INFINITY     ELY1+25   LL
                                                           NONE       28433.31250        7.02642        116.60641-    RAP1+25   LL

   146  WHT-SL    LL        .           129.28000-          .               .           68.18028-        INFINITY     WHT1+25   LL
                                                           NONE        8291.53906       68.18028        197.46028-    CAT1+25   LL

   154  WCOW-2    LL        .            30.45000           .          400.04395-        6.07901-        INFINITY     ELY1+25   LL
                                                           NONE       23061.99609        6.07901         24.37099     WCCW-1    LL

   155  WCCW-3    LL        .            32.89000           .          139.15425-       33.54576-        INFINITY     ELY1+25   LL
                                                           NONE       23061.99609       33.54576           .65576-    WCCW-1    LL

   156  WCAF-1    LL        .            25.00000           .               .          205.24062-        INFINITY     WCAFINV   LL
                                                           NONE        6836.57813      205.24062        160.24062-    A.PR-2    LL

   157  WCAF-2    LL        .            27.00000           .               .          216.10811-        INFINITY     WCAFINV   LL
                                                           NONE        7981.18750      216.10811        189.10811-    A.PR-2    LL

   158  WCAF-3    LL        .            29.00000           .               .          251.07965-        INFINITY     WCAFINV   LL
                                                           NONE       10358.82031      251.07965        222.07965-    COM-PAS   LL

   159  WFDR-1    LL        .            30.00000           .               .           95.70268-        INFINITY     SFCR-1    LL
                                                           NONE             .           95.70268         65.70268-    WFDR-2    LL

   161  WFDR-3    LL        .            34.00000           .          432.04736-       27.25388-        INFINITY     ELY1+25   LL
                                                           NONE             .           27.25388          6.74612     WFDR-2    LL
```

TABLE 34 (con't)

```
          TECH.MODEL N.ALTA                                                                      PAGE    38  -  76/103
                                                                              
NUMBER  .COLUMN.  AT  ...ACTIVITY...  ..INPUT COST..  ..LOWER LIMIT.  LOWER ACTIVITY  ...UNIT COST..  ..UPPER COST..  LIMITING  AT
                                                      ..UPPER LIMIT.  UPPER ACTIVITY  ...UNIT COST..  ..LOWER COST..  PROCESS.  AT

   165  SYLG-1    LL          .            3.00000          .               .          48.70866-        INFINITY     SYG-1SL   LL
                                                           NONE             .          48.70866         45.70866-    SYLG-3    LL

   166  SYLG-2    LL          .            3.00000          .               .          23.12315-        INFINITY     SYG-2SL   LL
                                                           NONE             .          23.12315         20.12315-    SYLG-3    LL

   188  B-LONG    LL          .           70.00000          .               .         207.57692-        INFINITY     BORTRANS  UL
                                                           NONE      46892.00000      207.57692        137.57692-    LGT-EQ    UL

   191  SOW-BT    LL          .           18.92999          .        9631.00000-       97.25056-        INFINITY     SOW-UN    LL
                                                           NONE        INFINITY        97.25056         78.32057-      NONE

   192  BOR-BT    LL          .           42.00000          .               .         195.01642-        INFINITY     BOR-SD    LL
                                                           NONE        INFINITY       195.01642        152.92642-      NONE

   194  HOG-SD    LL          .           43.50000-         .               .           2.11683-        INFINITY     SOW-UN    LL
                                                           NONE     109981.12500        2.11683         45.61683-    RAP1+2S   LL

   200  HAY-PR    LL          .           35.00000          .      136947.25000-      103.13638-        INFINITY     LGT-SAL   LL
                                                           NONE    1720885.00000      103.13638         68.13638-    HAY-FN    LL
```

TABLE 35: TECHNOLOGY MODEL FOR NORTHERN ALBERTA: SENSITIVITY ANALYSIS ROWS AT IMTERMEDIATE LEVEL

```
              TECH.MODEL N.ALTA                                                                              PAGE    39  -  76/103

   SECTION 3 - ROWS AT INTERMEDIATE LEVEL

 NUMBER  ...ROW..  AT  ...ACTIVITY...  SLACK ACTIVITY  ..LOWER LIMIT.  LOWER ACTIVITY  ...UNIT COST..  ..UPPER COST..  LIMITING  AT
                                                       ..UPPER LIMIT.  UPPER ACTIVITY  ...UNIT COST..  ..LOWER COST..  PROCESS.  AT

     8  STUB4     BS          .         66405.00000            NONE          .            INFINITY                          NONE
                                                          66405.00000     94.81042          4.61429                    BLY4S      LL

    17  COM-PAS   BS   46438.25000      68989.75000            NONE     46438.25000       115.61577                    SYLG-2     LL
                                                         115428.00000     93789.44141        1.92750                    NT-PAS     LL

    19  LIVETIME  BS   21747.46484      21747.46484-             .       21747.46484        INFINITY                         NONE
                                                                NONE     27570.70703      194.24890                    COMINV     LL

    20  L-MKA     BS  289111.00000    1285889.00000            NONE    289111.00000         3.63167                    WFORINV    LL
                                                        1575000.00000    354238.06250         2.15262                    WCOW-2     LL

    21  L-MKJ     BS  194411.18750     330588.81250            NONE    176863.62500         5.20126                    NT-PAS     LL
                                                         525000.00000    194485.73904         5.86819                    BLY4S      LL

    22  L-JKA     BS  226954.06250     298045.93750            NONE    211367.62891         5.85576                    NT-PAS     UL
                                                         525000.00000    244773.67188        11.44908                    A.EST-1    LL

    23  L-SKO     BS  252582.06250     272417.93750            NONE    238771.30078         6.60657                    NT-PAS     LL
                                                         525000.00000    252643.69791         7.09791                    BLY4S      LL

    24  L-TOTL    BS  951432.00000    2198568.00000            NONE    904683.29297         1.94402                    NT-PAS     LL
                                                        3150000.00000   1275932.12500          .71789                    HOG-SD     LL

    25  VAL-PRO   BS  12987513.0000-  12987513.0000            NONE  12994556.0938-          .06212                    BLY4S      LL
                                                                  .  11817740.0000-          .17079                    ERY-SL     LL

    27  B21       BS          .               .                NONE          .            INFINITY                         NONE
                                                                  .          .            INFINITY                         NONE

    29  LGT-EQ    BS          .         46892.00000            NONE          .            INFINITY                         NONE
                                                          46892.00000      INFINITY       207.57692                    B-LONG     LL

    30  BOR-EQ    BS          .       5002911.00000            NONE          .           2065.38201                    COM-PR     LL
                                                        5002911.00000          .            INFINITY                         NONE

    31  BORTRANS  BS          .               .                NONE     46892.00000-      207.57692                    B-LONG     LL
                                                                  .       INFINITY        516.34570                    COM-PR     LL

    34  K-TRAN    BS          .               .                  .       INFINITY-          5.42665                    K-FERT     LL
                                                                  .          .            INFINITY                         NONE

    40  LTR-PR    BS  197044.75000     277955.25000            NONE    197044.75000         3.71769                    LTR-PR     LL
                                                         475000.00000    197137.58688         4.71238                    BLY4S      LL

    41  MTR-PR    BS  148001.81250     755998.18750            NONE    148001.81250         2.09154                    MTR-PR     LL
                                                         904000.00000    164407.16797        12.43607                    A.EST-1    LL
```

TABLE 35 (con't)

```
                 TECH.MODEL N.ALTA                                                                              PAGE    40  -  76/103

  NUMBER  ...ROW..  AT  ...ACTIVITY...  SLACK ACTIVITY  ..LOWER LIMIT.  LOWER ACTIVITY  ...UNIT COST..  ..UPPER COST..  LIMITING  AT
                                                        ..UPPER LIMIT.  UPPER ACTIVITY  ...UNIT COST..  ..LOWER COST..  PROCESS.  AT

      42  STR-PR    BS    80368.68750    457631.31250            NONE     80368.68750         1.05231                 STR-PR    LL
                                                         538000.00000     80368.68750        12.05652                 WHT1+2F   LL

      43  SWA-PR    BS    14865.62500    141134.37500            NONE     14865.62500         4.13077                 SWA-PR    LL
                                                         156000.00000     14873.13432        58.25865                 BLY4S     LL

      44  COM-PR    BS    35711.00000    172289.00000            NONE     35711.00000        10.32691                 COM-PR    LL
                                                         208000.00000     35740.41820        14.67116                 BLY4S     LL

      49  FAL-IN    BS          .               .               .               .          INFINITY                    NONE
                                                                .               .          INFINITY                    NONE

      58  COP-IN    BS          .               .               .               .          INFINITY                    NONE
                                                                .               .          INFINITY                    NONE

      65  BULLINV   BS      966.18237       966.18237-          .         966.18237        INFINITY                    NONE
                                                             NONE        1224.89380      4372.27734                 COWINV    LL

      67  BPCINV    BS     2167.82788      2167.82788-          .        2167.82788        INFINITY                    NONE
                                                             NONE        2748.29956      1948.66272                 COWINV    LL

      70  WCAFINV   BS          .               .               .               .          INFINITY                    NONE
                                                             NONE        6836.57422       205.24062                 WCAF-1    LL

      91  SCW-UN    BS          .         28893.00000            NONE     INFINITY-          32.41685                 SCW-RT    LL
                                                          28893.00000     4102.24219        56.75233                 HOG-SD    LL

      92  SCW-RP    BS          .          6571.00000            NONE           .          INFINITY                    NONE
                                                           6571.00000      205.11211      1135.04663                 HOG-SD    LL
```

TABLE 36: TECHNOLOGY MODEL FOR NORTHERN ALBERTA: SENSITIVITY ANALYSIS COLUMNS AT INTERMEDIATE LEVEL

```
              TECH.MODEL N.ALTA                                                                          PAGE    41  -  76/103

   SECTION 4 - COLUMNS AT INTERMEDIATE LEVEL

 NUMBER  .COLUMN.  AT  ...ACTIVITY...   ..INPUT COST..   ..LOWER LIMIT.  LOWER ACTIVITY  ...UNIT COST..  ..UPPER COST..  LIMITING  AT
                                                         ..UPPER LIMIT.  UPPER ACTIVITY  ...UNIT COST..  ..LOWER COST..  PROCESS.  AT

    100  BLY1+2S   BS        64.64348         1.74000           .          1815.51741-          .52813         2.26813   BLY3F     LL
                                                                NONE      43145.40520          4.63744         2.89744-  BRY-SL    LL

    106  OAT1+2S   BS     17375.29125         3.11000           .         45029.65625-         6.26038         9.27028   OAT4S     LL
                                                                NONE      17443.89442         12.85803         9.74803-  ELY4F     LL

    109  OAT4F     BS     23420.99609         3.11000           .         23351.62263         12.71711        15.82711   BLY4F     LL
                                                                NONE      23420.99609         INFINITY        INFINITY-      NONE

    111  BAP1+2F   BS     18902.99609         2.12000           .         18902.99609          4.06022         6.18022   WHT1+2F   LL
                                                                NONE      18902.99609         INFINITY        INFINITY-      NONE

    112  BAP1+2S   BS     36156.07031         2.12000           .         37352.99219-         5.52561         7.64561   BRY-SL    LL
                                                                NONE      36220.35651           .53106         1.58894   BLY3F     LL

    113  BAP3F     BS     18489.99609         2.12000           .         18427.57520           .54693         2.66693   BLY2F     LL
                                                                NONE      18489.99609         INFINITY        INFINITY-      NONE

    117  FAL-PN    BS     12327.07812         2.14000           .          4011.18359         83.48044        85.62044   STUB1+2   LL
                                                                NONE      12348.88451         20.06212        17.92212-  ELY4S     LL

    119  WHT1+2S   BS          .              2.30000           .              .               3.46313         5.76313   WHT1+2F   LL
                                                                NONE      11913.12500         47.45349        45.15349-  WHT-SL    LL

    125  A.PR-1    BS          .              1.56000           .              .              INFINITY        INFINITY       NONE
                                                                NONE       9420.36328         21.63876        20.07876-  A.EST-1   LL

    126  ALFA-SL   BS          .             50.00000-          .              .              INFINITY        INFINITY       NONE
                                                                NONE      17159.62500         11.88943        61.88943-  A.EST-1   LL

    127  A.EST-2   BS      1085.67407         2.59000           .              .             108.19382       110.78382   A.EST-1   LL
                                                                NONE       2241.63672        393.84448       391.25448-  WCCW-2    LL

    128  A.PR-2    BS      9429.35719              .            .              .              21.63876        21.63876   A.EST-1   LL
                                                                NONE      11208.17993         78.76895        78.76895-  WCCW-2    LL

    129  ALFA-SP   BS     17253.91797        48.00000-          .              .              11.82446        36.17554-  A.EST-1   LL
                                                                NONE      20510.97559         43.04314        91.04314-  WCOW-2    LL

    130  N-FERT    BS      3415.29297        29.39999           .          3415.29297         88.89243       118.29242   WHT1+2F   LL
                                                                NONE       3418.43573        139.20335       169.80336-  ELY4S     LL

    131  P-FERT    BS     11977.81250        29.39999           .         11977.81250         37.49947        66.89946   WHT1+2F   LL
                                                                NONE      11986.64766         49.51947        20.11948-  ELY4S     LL

    133  LTP-SB    BS    197800.81250          .96000           .        190032.20312         17.97679        18.93679   WCOW-2    LL
                                                                NONE     197893.64938          4.71238         3.75238-  BLY4S     LL
```

TABLE 36 (con't)

```
            TECH.MODEL N.ALTA                                                                        PAGE    42  -  76/103

 NUMBER  .COLUMN.  AT  ...ACTIVITY...  ..INPUT COST..  ..LOWER LIMIT.  LOWER ACTIVITY  ...UNIT COST..  ..UPPER COST..  LIMITING  AT
                                                       ..UPPER LIMIT.  UPPER ACTIVITY  ...UNIT COST..  ..LOWER COST..  PROCESS.  AT

    134  MTR-SR    BS   151471.43750        .61000          .          151471.43750       11.99122        12.60122   *FDRINV    LL
                                                           NONE        170705.30469       10.60724         9.99724-  A.EST-1    LL

    135  STR-SR    BS    80368.62500        .39000          .           80368.62500        9.81437        10.20437   *FDRINV    LL
                                                           NONE         80368.62500       12.05652        11.66652-  *HT1+2F    LL

    136  SWA-SR    BS    14865.57031       5.39000          .           14865.57031      131.97229       137.36229   *FDRINV    LL
                                                           NONE         14873.07963       58.25865        52.86865-  BLY4S      LL

    137  COW-SR    BS    35710.95703      14.70000          .           23779.45703       58.18333        72.88333   STUB1+2    LL
                                                           NONE         35740.37523       14.87116          .17116-  BLY4S      LL

    144  OAT-SL    BS    34306.35937      87.64999-         .           16771.60937       13.27717        74.37283-  HOG-SO     LL
                                                           NONE         34306.35937       21.52834       109.17833-  *HT1+2F    LL

    145  RAP-SL    BS    29646.92734     282.50000-         .           16087.50391       14.73497       267.76503-  BRY-SL     LL
                                                           NONE         36161.75391       16.69434       259.19454-  OAT4S      LL

    147  STR-GR    BS    62276.69141       1.28000          .           62276.69141       41.34218        42.42218   *FDRINV    LL
                                                           NONE         62299.11433       19.51050        18.43050-  BLY4S      LL

    148  STR-HY    BS   101530.43750        .50000          .           91666.82422       14.21325        14.71325   *COW-2     LL
                                                           NONE        128716.89844       41.60744        41.10744-  COWINV     LL

    149  BRY-SD    BS       51.71478       8.22000          .              49.93673       19.20074        27.42074   BLY3F      LL
                                                           NONE         34516.32806        5.79680         2.42320   BRY-SL     LL

    150  OAT-SD    BS    33452.94922       6.57000          .           33452.94922       23.57845        30.14845   *FDRINV    LL
                                                           NONE         33452.94922       19.69055        13.12055-  *HT1+2F    LL

    151  RAP-SP    BS    58839.25781      21.18999          .           25914.41406        6.90702        28.09701   BRY-SL     LL
                                                           NONE         72739.48047        7.82547        13.36452   OAT4S      LL

    152  WHT-SP    BS          .           9.66000          .                 .             24.53050        34.19050   *HT1+2F    LL
                                                           NONE         11436.59766       49.43073        39.77073-  *HT-SL     LL

    153  *COW-1    BS    23061.99609      30.00000          .          130820.75391-       6.07901        36.07901   *COW-2     LL
                                                           NONE         29237.22656      183.17671       153.17671-  COWINV     LL

    160  *FDR-2    BS          .          32.00000          .          107345.68750-      27.25388        59.25388   *FDR-3     LL
                                                           NONE               .         INFINITY        INFINITY-      NONE

    162  SCOW-1    BS    13654.93750       5.77600          .            7905.79688       54.92839        60.70439   IF-PAS     LL
                                                           NONE         13654.93750     INFINITY        INFINITY-      NONE

    163  SCOW-2    BS     3945.93311       5.77600          .                 .             23.12999        28.90599   NT-PAS     LL
                                                           NONE          3945.93311     INFINITY        INFINITY-      NONE

    164  SCOW-3    BS     3865.85034       5.77600          .            3869.85034     INFINITY        INFINITY       NONE
                                                           NONE          7815.78296       23.12999        17.35399-  NT-PAS     UL
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TABLE 36 (con't)

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          TECH.MODEL N.ALTA                                                                     PAGE   43 - 76/103

 NUMBER  .COLUMN.  AT  ...ACTIVITY...  ..INPUT COST..  ..LOWER LIMIT.  LOWER ACTIVITY  ...UNIT COST..  ..UPPER COST..  LIMITING  AT
                                                       ..UPPER LIMIT.  UPPER ACTIVITY  ...UNIT COST..  ..LOWER COST..  PROCESS.  AT

   167  SYLG-3     BS         .           3.00000          .                .             23.12315        26.12315     SYLG-2    LL
                                                          NONE         8059.66641        277.35208       274.35208-    *CAF-1    LL

   168  SFDR-1     BS         .           3.00000          .                .             INFINITY        INFINITY         NONE
                                                          NONE              .             96.66937        93.66937-    *FDR-1    LL

   169  WCLLCWSL   BS     1591.27783    150.00000-         .           1591.27783          INFINITY        INFINITY         NONE
                                                          NONE         2017.36865       2654.73682      2804.73682-    COWINV    LL

   170  SYG-1VAD   BS         .         100.00000-         .                .              INFINITY        INFINITY         NONE
                                                          NONE              .            243.54332       343.54332-    SYLG-1    LL

   171  SYG-2VAD   BS         .         125.00000-         .                .              INFINITY        INFINITY         NONE
                                                          NONE              .            115.61577       240.61577-    SYLG-2    LL

   172  SYG-3VAD   BS         .         150.00000-         .                .             115.61577        34.38423-    SYLG-2    LL
                                                          NONE         1011.81299       1386.76123      1536.76123-    *CAF-1    LL

   173  SYG-1SL    BS         .         100.00000-         .                .              INFINITY        INFINITY         NONE
                                                          NONE              .             63.25600       163.25600-    SYLG-1    LL

   174  SYG-2SL    BS         .         125.00000-         .                .              INFINITY        INFINITY         NONE
                                                          NONE              .             30.03006       155.03006-    SYLG-2    LL

   175  SYG-3SL    BS         .         150.00000-         .                .              30.03006       119.96994-    SYLG-2    LL
                                                          NONE         3895.48193        360.19751       510.19751-    *CAF-1    LL

   176  FATDE*SL   BS         .         250.00000-         .                .              30.45100       219.54900-    *FDRINV   LL
                                                          NONE              .              INFINITY        INFINITY-        NONE

   177  SCULC*SL   BS     1953.83569    150.00000-         .           1953.83569          INFINITY        INFINITY         NONE
                                                          NONE         2477.00732       2162.11768      2312.11768-    COWINV    LL

   178  MULLSL     BS      107.35361    200.00000-         .            107.35361          INFINITY        INFINITY         NONE
                                                          NONE          136.09932      39350.52734     39550.52734-    COWINV    LL

   179  SCOWVAD    BS    19495.41406    190.00000-         .          19495.41406          INFINITY        INFINITY         NONE
                                                          NONE        24715.63281        216.68794       406.68794-    COWINV    LL

   180  SCAFVAD    BS    14750.38281     50.00000-         .          14750.38281          INFINITY        INFINITY         NONE
                                                          NONE        18700.04395        286.39380       336.39380-    COWINV    LL

   181  SCAFSL     BS     3929.14209     50.00000-         .           3929.14209          INFINITY        INFINITY         NONE
                                                          NONE         4981.23486       1075.15112      1125.15112-    COWINV    LL

   182  SFDR-1SL   BS         .         200.00000-         .                .              INFINITY        INFINITY         NONE
                                                          NONE              .             97.64583       297.64583-    *FDR-1    LL

   183  BPCSL      BS      184.49599    150.00000-         .            184.49599          INFINITY        INFINITY         NONE
                                                          NONE          233.89784      22897.09375     23047.09375-    COWINV    LL
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TABLE 36 (con't)

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         TECH.MODEL N.ALTA                                                                      PAGE    44  -  76/103

NUMBER  .COLUMN.  AT  ...ACTIVITY...  ..INPUT COST..  ..LOWER LIMIT.  LOWER ACTIVITY  ...UNIT COST..  ..UPPER COST..  LIMITING  AT
                                                      ..UPPER LIMIT.  UPPER ACTIVITY  ...UNIT COST..  ..LOWER COST..  PROCESS.  AT

  184  WCAF-1SL  BS          .          50.00000-           .                .          INFINITY       INFINITY        NONE
                                                          NONE     1025.48633      1368.27075     1418.27075-  WCAF-1     LL

  185  WCAF-2SL  BS          .          65.00000-           .                .          INFINITY       INFINITY        NONE
                                                          NONE     1197.17773      1440.72995     1505.72995-  WCAF-2     LL

  186  WCAF-3SL  BS          .          80.00000-           .                .          INFINITY       INFINITY        NONE
                                                          NONE     1553.82278      1673.86450     1753.86450-  WCAF-3     LL

  187  B-CASH    BS     4579.94766      44.00000            .      4265.32471       635.19775      679.19775   BRY-SL     LL
                                                          NONE     4582.27326       180.35994      136.35994-  ELY4S      LL

  189  LGT-BAL   BS     9139.69531    1000.00000            .      8530.64917       317.59888     1317.59888   BRY-SL     LL
                                                          NONE     9164.64653        90.17996      909.82004   BLY4S      LL

  192  SOW-UN    BS          .          71.17000            .                .          INFINITY       INFINITY        NONE
                                                          NONE     4102.24219        56.75233       14.41766   HOG-SD     LL

  193  WTN-SD    BS          .          65.25000-           .                .          INFINITY       INFINITY        NONE
                                                          NONE     3692.01831        63.05815      128.30815-  HOG-SD     LL

  195  CSOW-S    BS          .          23.84999-           .                .          INFINITY       INFINITY        NONE
                                                          NONE     2051.12109       113.50467      137.35466-  HOG-SD     LL

  196  POR-SD    BS          .          12.50000-           .                .          INFINITY       INFINITY        NONE
                                                          NONE       INFINITY       195.01642      207.51642-  BCR-BT     LL

  197  HAY-PH    BS    78471.75000       3.25000            .     68683.28516        14.32237       17.57237   WCOW-2     LL
                                                          NONE    99483.87506        53.83363       50.58363-  COWINV     LL

  198  P-T-PH    BS    22120.99609       2.64000            .     12807.38672        33.90642       36.54642   IR-FAS     LL
                                                          NONE    22120.99609        INFINITY       INFINITY-       NONE

  199  P-N-PH    BS    59188.99609       1.00000            .                .           1.54200        2.54200   NT-PAS     LL
                                                          NONE    59188.99609        INFINITY       INFINITY-       NONE

  201  COMPAS    BS    48938.20313       1.90000            .     48938.20313       115.61577      117.51577   SYLG-2     LL
                                                          NONE    93789.39453         1.92750         .02750-  NT-PAS     LL

  202  GRNFEED   BS    41110.95313       5.25000            .     38975.17773        65.64378       70.89378   WCOW-2     LL
                                                          NONE    52119.08984       102.75659       97.50659-  COWINV     LL
```

be explained from viewing the model. However, the tables show the sensitivity of the program to price and resource changes. As an example, in Table 35, the available time of middle tractors is part of the base solution (BS) at 148,001 hours. There are 755,998 hours of slack activity or nonuse. Column six shows the lower limit of zero and an upper limit of 904,000 hours. Going on to columns seven, eight and ten, the availability of middle tractors could range from 148,001 hours to 164,407 hours, and a per unit cost of $2.89 to $12.44 without affecting the base solution. If the available time of middle tractors were to move beyond the lower activity, the establishment of alfalfa for the plant could be affected, and if there was a move beyond the upper activity, it would affect a change in wheat production on fallow land of classes 1 and 2.

Comparative Simulations

The comparison of farming patterns with and without the plant was based on the following assumptions:

1. The number of cattle was not allowed to decline by more than a net cull rate on the premise that producers would not likely abandon cattle as a hedge against crop risk and major uses of nonarable land.

2. Alfalfa is produced on stubble land of soil class 3 in competition with the major cereals and greenfeed.

3. Alfalfa can either be marketed as hay or as a supply to the dehydration plant.

The analytical procedure involved changing the price paid in each alternative market. By this process, relative prices for each market were established at $49.82 per ton for alfalfa hay and $36.17 per ton for the plant. A ceteris paribus increase over the relative price for either case resulted in diverting the alfalfa to one or the other of the respective markets. These relative prices are in the neighbourhood of farmer paid prices and the price used in cash flows projections.

Examination of the results (Table 37) shows that the presence of the dehydration plant would not be expected to change the cropping and livestock patterns in Smoky Lake County. The acreage for the individual crop included in the production with the plant is the same without plant. Wheat and hogs are primary activities not included in either case and mixed hay and rape account for the highest acreage, 78,471 acres and 73,549 acres, respectively, using over 60 percent of the available land. Although the results are in contradiction to what is going on in the County, it should be remembered that Linear programming is approximation of reality. It does not represent any external economies and diminishing returns to scale. In addition, 1974 experienced unusually high prices but farmers do take time to adjust. Therefore, Linear programming only indicates the direction to which to adjust.

The assumption regarding livestock was relaxed. As a result, the livestock activity was excluded from the objective

TABLE 37

COMPARATIVE SIMULATIONS OF CROPPING AND LIVESTOCK PATTERNS IN SMOKY LAKE COUNTY WITH AND WITHOUT AN ALFALFA DEHYDRATION PLANT, 1974

Enterprises	Units	$/CWT	With Plant	Without Plant
Barley	acres	109.58	64	64
Oats	acres	87.65	40,796	40,796
Rape	acres	282.50	73,549	73,549
Fallow	acres	N.A.	12,327	12,327
Wheat	acres	129.28	nil	nil
Alfalfa Establish	acres	N.A.	1,886	1,886
Alfalfa Production	acres	37.17[1]	9,428	nil
Alfalfa Hay	acres	36.00[1]	nil	9,428
Mixed Hay	acres	N.A.	78,471	78,471
Improved Pasture	acres	N.A.	22,121	22,121
Wintering Cows	cows	N.A.[2]	23,062	23,062
Summering Cows	cows	N.A.[2]	21,468	21,468
Hogs	sows	43.50[3]	nil	nil

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[1] The price for alfalfa hay is $50/ton. The quoted prices ($36.17 and $36.00 per ton) are competitive prices for plant harvested alfalfa on a sun cured hay basis.

[2] The prices are not quoted due to the variety of outlets for product.

[3] The price of $43.50 is or market hogs.

function. But the exclusion of livestock from the activities increased the production of alfalfa from 1,886 acres to 8,737 acres, almost four times the original objective.

Comparison was made of resource use and agricultural enterprises in Smoky Lake County (Table 38). The results show that the presence of the plant decreased the value of agricultural production from $13,038,959 to $12,987,514. At the same time, the presence of the plant reduced operating costs, resulting in a higher net farm income ($3,304,912) than without plant ($3,100,894). The plant has also reduced the labour requirements thus increasing the problem or underemployment from 69 percent to 70 percent.

TABLE 38

SELECTED RESULTS OF COMPARATIVE SIMULATIONS OF RESOURCE USE AND AGRICULTURE ENTERPRISES IN SMOKY LAKE COUNTY WITH AND WITHOUT AN ALFALFA DEHYDRATION PLANT, 1974

Item	Units	Value With Plant	Value Without Plant
Value of Agr. Prodn.	Dollars	12,987,514	13,038,959
Operating Costs	Dollars	4,599,848	4,662,683
Net Farm Income	Dollars	3,304,912	3,100,894
Total Labour Used	Hours	951,631	969,281
Total Labour Unused	Hours	2,198,368	2,180,718
Underemployment	Percent	70%	69%

CHAPTER V

SUMMARY AND CONCLUSIONS

Summary

This study attempted to do four things:

1. To examine the financial viability of Smoky Lake Alfalfa Processing Plant.

2. To examine the competitive impact of alfalfa production on other farm enterprises.

3. To examine the regional impact of the plant as a market outlet for local resource-based production.

4. To examine policy recommendations for the future of the plant.

The procedures followed in this study were:

1. To define alfalfa processing as related to the primary agriculture concept and to examine the recent expansion of alfalfa dehydration in the province of Alberta.

2. To investigate the alfalfa industry in Alberta in terms of production, processing and markets for alfalfa products. The main area of this study was Smoky Lake County and, in general, the Alberta perspective.

3. To review literature on the concept of cash flow. The concept of cash flow was defined and the areas where cash flow analysis is applicable were identified. The importance of discounting cash flows was emphasised and alternative measures of financial viability examined. A detailed documentation of

how the cash flows projections for Smoky Lake Alfalfa Processing Plant were derived formed the basis of the analysis. The sensitivity analysis provided a check on the estimated projections by varying the price paid for the final product and throughput percent of capacity.

4. To review literature on the theory of linear programming. The formulation and solution of linear programming problems were attempted. A linear programming model for Northern Alberta was applied in the analysis. The model was described with emphasis on size and density. The column activity prices and cost figures and the right-hand side constaints for Smoky Lake County were listed.

The sources of data were outlined, especially data collected through farm questionnaires. The single-stage sampling and the actual survey were explained.

The data obtained were converted to standard units for inclusion in the linear programming model. The objective was to maximize cash flow by minimizing an equation which expresses all production in negative numbers and all input coefficients in positive numbers.

Conclusions

The results of the cash flows projections show that the Smoky Lake Alfalfa Processing Plant is financially viable under defined assumptions. The net present value and the financial rate of return indicate that the plant is capable of paying a higher rate of interest than that charged in the market place and still recover the capital invested into it. The assumed price in the analysis is lower than that currently obtained on the market. This ensures overestimation of revenue. On the other hand, the assumption made for the level of throughput is about 25 percent higher than the current one. It would appear that if the assumed capacity level of throughput were not achieved, the results could be lower than expected.

The phasing of capital outflows needs mention. To project debt service outflows, no future long term borrowing was taken into account. If a substantial amount of money is borrowed in the future, the expected financial position of the plant might be affected.

The study attempted to test what happens to the financial viability of the plant if the assumptions made for price and capacity were different from the actual results. The results of sensitivity analysis indicated that the most likely assumption on price is realistic and that the plant is viable at a lower throughput percent of capacity than that projected. On the other hand, at a price lower than $60 per ton of pellets, the financial rate of return of the plant is less than the opportunity cost of capital, even at full capacity of throughput.Therefore, all things being equal, the selling price and throughput are identified as the most important variables responsible for the financial viability of the plant.

The analysis of the competitive impact of alfalfa production and the regional economic impact of the dehydration plant on farming enterprises were also attempted. The results of the activity levels showed rape, oats, alfalfa and barley as the only cropping activities. The results indicate that rape is the most important crop activity followed by (in the order of importance) oats, alfalfa, and barley. Wheat production was not competitive with the other cropping activities. These activities are tied closely to the relative selling prices and the 1974 commodity prices greatly favoured rape production. The sensitivity analysis indeed identified the wheat sale activity and the relatively low price attached thereto as limiting production of wheat. Given the current price paid for the various crops, a higher proportion of the available land should be allocated to rape production rather than to barley, oats, alfalfa or wheat. It can also be concluded that since alfalfa ranks third in importance at given prices, its production for processing purposes would not have a significant impact on the cropping and livestock patterns in the county. Alfalfa is not as much a competitive as a supplementary enterprise within the given soil classification.

The comparative simulations indicate that no change in the cropping and livestock patterns would be expected since the establishment of the dehydration plant. It is therefore concluded that the plant is not likely to have regional impact on resource allocation except to slightly shift the demand for labour off farms and into the part time market. This conclusion is supported by the fact that as few as 30 farmers market their alfalfa through the plant, many of them for labour saving reasons. The president of the plant was of the opinion that farmers involved are capable of doubling their supply. This is an indication that there is potential impact for increased production of alfalfa and the location of the plant in Smoky Lake is justifiable.

The plant also has very few openings for wage employment. At the peak periods such as the first cut of alfalfa, a total of 35 farmers are employed. Most of these employed, as many as 28 men, are involved in field operations. Another indication is that those who market their alfalfa through the plant and those employed at the plant are centered in and around Smoky Lake town where the plant is located. It would perhaps be more meaningful to speak of local rather than regional impact because of the limited scope in which the influence of the plant is felt.

By comparative simulations it was possible to establish 'trigger prices' for unprocessed alfalfa below which alfalfa production is not profitable. The trigger price in this analysis is $36.17 per ton of suncured hay equivalent or about $12.00 per ton on a fresh cut basis assuming a 3:1 conversion ratio. This price is in the neighbourhood of farmer paid prices established in recent years by the plant. Therefore there seems to be little room for reducing this price to improve the cash flow of the plant. Given the marked shortfall in deliveries of fresh alfalfa to the plant, this price may be insufficient as an incentive to produce, and may actually discourage efforts and expense to improve the low yields.

Recommendations

(1) Throughput and price have been identified as the most important variables for improving the cash flows of the plant. But the plant cannot control the price at which to sell. It is therefore recommended that throughput should be increased if losses have to be avoided. It has been suggested[1] that a major improvement in the efficiency of the alfalfa processing industry could be achieved by extending the length of time during which plant facilities are in operation each year. Related to this is the fact that frequent mechanical problems can interfere with the available time for operation; therefore, it is important to employ a well-trained mechanic.

2. Another recommendation is that future expansion of the plant facilities should be planned and executed,only after the present facilities have been utilized to full capacity. A historical throughput of capacity ratios shows that the plant has been operating at slightly less than half capacity. It would

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[1] Alberta Department of Agriculture, op. cit.

therefore be unrealistic and costly if more funds were committed to creating extra facilities.

3. Short term borrowing from commercial banks should not be encouraged. Short term borrowing can be costly and should not be resorted to unless absolutely necessary. Related to short term borrowing is the fact that management is currently negotiating for a long term loan. The amount sought should be related to the expected throughput and price. Only after making sure that the loan will add more to benefits than to costs can such borrowing be justified.

4. A policy recommendation is that if the plant has no significant impact on the local economy, incentive loans and loan forgiveness should not be extended to the plant. But the plant has the potential to add to income without outcompeting other enterprises and as such the plant merits assistance. In fact it would seem that the plant is promoting farm adjustments since it is the old who are very much involved in growing alfalfa in the county.

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APPENDICES

Appendix 1. Establishing Alfalfa: Variable Costs, Use of Fertilizer and the Value of Cover Crop in Terms of the Value Equivalent of Oats - County of Smoky Lake, 1974

		Labour Use	Use of Machinery	Cost of Machinery		Expenditure on Seeds	Amount of Fertilizer Applied		Yield of Cover Crop
No.	Land Available in Acres	Man Hours Per Acre	Tractor Hours Per Acre	Tractor's Variable Costs Per Hour	Tractor's Variable Costs Per Acre	Cost of Seed Per Acre	Fertilizer Used Per Acre in Pounds		Oats Yield Equivalent Per Acre
1	50	1.14	1.14	3.74	4.26	6.20	7.7	33.6	75.00
2	30	1.43	1.43	3.24	4.63	11.80	20.0	--	92.00
3	80	2.25	1.87	2.22	4.15	9.10	--	--	50.00
4	30	2.63	2.67	1.61	4.23	8.50	--	--	64.00
5	30	0.93	0.93	1.78	1.65	8.85	5.5	24.0	75.00
6	50	0.96	0.96	3.59	3.45	5.95	17.0	--	96.00
7	125	1.84	1.84	1.61	2.96	7.90	--	--	75.00
8	60	2.46	2.46	1.61	3.96	4.80	--	--	55.00
9	40	1.15	0.90	2.84	2.56	5.20	8.8	38.4	72.00
10	40	3.67	3.30	1.61	5.31	6.60	21.0	--	--
11	35	1.68	1.68	3.74	6.28	6.20	--	--	53.00
12	50	2.14	2.14	1.98	4.24	9.70	8.8	38.4	60.80
13	60	1.61	1.55	1.20	1.86	8.40	--	--	50.00
14	10	3.30	3.30	1.20	3.96	7.90	5.5	24.0	64.00
15	30	1.63	1.63	1.98	3.23	8.40	--	--	53.00
16	44	3.36	3.36	1.20	4.03	6.20	--	--	56.00
17	10	2.20	2.20	1.98	4.36	7.20	--	--	50.00
18	30	3.26	3.26	1.98	6.45	7.60	10.5	--	62.50
19	40	1.90	1.90	2.53	4.80	7.30	6.4	6.0	60.80
20	10	2.30	1.80	1.20	2.16	9.70	--	--	70.00
21	15	3.66	1.60	1.78	2.84	7.20	--	--	53.00
22	40	2.37	2.37	3.34	7.93	8.70	--	--	--
23	125	2.36	2.36	1.20	2.83	8.50	--	--	64.00
24	100	1.80	1.80	3.34	6.01	7.50	8.0	10.0	48.00
25	18	2.50	2.50	1.61	4.02	7.70	8.0	10.0	48.00
26	23	2.43	2.43	1.61	3.91	7.70	5.5	24.0	69.00
27	43	2.55	2.55	1.31	3.34	8.75	--	--	100.00
28	50	1.60	1.60	1.61	2.58	7.30	5.5	24.0	72.00
29	160	1.91	1.91	1.31	2.50	9.20	--	--	56.00
30	25	3.48	3.48	1.61	5.60	5.80	5.5	24.0	80.00
31	182	1.16	1.16	1.20	1.39	9.80	--	--	60.00
32	111	2.29	2.29	1.20	2.75	7.60	6.4	8.0	48.00
33	90	1.06	1.06	1.20	1.27	7.20	42.0	--	--
34	20	1.75	1.75	1.20	2.10	8.50	--	--	48.00
35	40	1.82	1.82	3.24	5.90	6.10	11.2	14.0	64.00

NOTE: The blanks indicate that fertilizer was not applied.

Appendix 2. Maintaining Alfalfa in the Second Year: Variable Costs, Fertilizer Use and the Yields of Alfalfa - County of Smoky Lake, 1974

No.	Acres	Man Hours Per Acre	Tractor Hours Per Acre	Tractor's Variable Costs Per Hour	Tractor's Variable Costs Per Acre	Total Cost of Twine	Fertilizer Pounds Used Per Acre		Alfalfa Yield Per Acre (Tons)
							N	P	
				$	$	$			
1	50	2.4	2.4	3.74	8.97	49.00	--	--	3.0
2	30	3.7	0.9	3.24	2.92	84.00	--	--	1.5
3	80	1.43	1.43	2.22	3.17	42.00	--	--	2.0
4	30	1.83	1.83	1.61	2.95	42.00	--	--	2.0
5	30	2.4	2.4	1.78	4.27	56.00	--	--	1.5
6	50	0.8	0.8	3.59	2.87	56.00	--	--	1.5
7	125	1.84	1.84	1.61	2.96	63.00	34.0	--	1.6
8	60	2.08	2.08	1.61	3.35	63.00	--	--	1.5
9	40	1.05	0.8	2.84	2.27	42.00	--	--	1.5
10	40	1.75	1.75	1.61	2.82	49.00	--	--	1.8
11	35	1.42	1.42	3.74	5.31	35.00	21.0	--	2.0
12	50	1.8	1.8	1.98	3.56	42.00	--	--	1.5
13	60	1.3	1.3	1.20	1.56	28.00	11.0	48.0	1.5
14	10	1.1	1.1	1.20	1.32	14.00	--	--	1.5
15	30	2.27	2.27	1.98	4.49	35.00	--	--	1.5
16	44	2.2	2.2	1.20	2.64	42.00	--	--	1.5
17	10	3.3	3.3	1.98	6.53	14.00	--	--	1.5
18	30	1.86	1.86	1.98	3.68	28.00	--	--	1.6
19	40	1.22	1.22	2.53	3.09	28.00	--	--	1.3

Appendix 2. Continued

No.	Acres	Man Hours Per Acre	Tractor Hours Per Acre	Tractor's Variable Costs Per Hour	Tractor's Variable Costs Per Acre	Total Cost of Twine	Fertilizer Pounds Used Per Acre		Alfalfa Yield Per Acre (Tons)
							N	P	
				$	$	$			
20	10	2.1	2.1	1.20	2.52	14.00	--	--	1.5
21	15	1.8	1.4	1.78	2.49	21.00	--	--	2.0
22	40	0.75	0.75	3.34	2.50	42.00	--	--	1.5
23	125	0.81	0.81	1.20	0.97	105.00	--	--	1.5
24	100	0.8	0.8	3.34	2.67	70.00	--	--	1.5
25	18	1.5	1.5	1.61	2.41	14.00	--	--	1.5
26	23	2.0	2.0	1.61	3.22	21.00	--	--	1.5
27	43	2.55	2.55	1.31	3.34	56.00	--	--	2.0
28	50	--	--	--	--	--	--	--	1.5
29	160	--	--	--	--	--	--	--	1.5
30	25	--	--	--	--	--	--	--	2.0
31	182	--	--	--	--	--	--	--	2.0
32	111	--	--	--	--	--	--	--	1.8
33	90	--	--	--	--	--	21.0	--	2.3
34	20	--	--	--	--	--	--	--	1.5
35	40	--	--	--	--	--	--	--	1.5

NOTE: The blanks under Man Hours Per Acre, Tractor Hours Per Acre, Tractor Costs Per Hour and Tractor Costs Per Acre indicate that the farmers had their harvest operations done for them.

Appendix 3. Maintaining Alfalfa in the Third Year: Variable Costs, Use of Fertilizer and the Yields of Alfalfa - County of Smoky Lake, 1974

				Cost of Machinery			Fertilizer Use in Pounds Per Acre		
No.	Acres	Man Hours Per Acre	Use of Machinery Hours Per Acre	Variable Costs Per Hour	Variable Costs Per Acre	Cost of Twine	N	P	Alfalfa Yield Per Acre (Tons)
				$	$	$			
1	50	2.4	2.4	3.74	8.97	56.00	--	--	1.5
2	30	4.06	0.9	3.24	2.92	64.00	--	--	2.5
3	80	1.43	1.43	2.22	3.17	96.00	--	--	2.0
4	30	1.83	1.83	1.61	2.95	80.00	21.0	--	3.0
5	30	2.4	2.4	1.78	4.27	64.00	--	--	2.5
6	50	0.8	0.8	3.59	2.87	56.00	--	--	1.5
7	125	1.84	1.84	1.61	2.96	160.00	--	--	2.0
8	60	2.0	0.66	1.61	1.06	72.00	--	--	1.5
9	40	1.55	0.8	2.84	2.27	48.00	--	--	1.5
10	40	1.45	1.45	1.61	2.33	64.00	--	--	2.0
11	35	1.42	1.42	3.74	5.31	40.00	--	--	1.5
12	50	1.6	1.6	1.98	3.17	56.00	--	--	1.5
13	60	1.3	1.3	1.20	1.56	72.00	--	20.0	1.5
14	10	1.1	1.1	1.20	1.32	16.00	--	--	2.0
15	30	2.23	2.23	1.98	4.41	32.00	--	--	1.5
16	44	2.2	2.2	1.20	2.64	48.00	--	--	1.5
17	10	5.0	5.0	1.98	9.90	16.00	--	--	2.0
18	30	2.23	2.23	1.98	4.41	32.00	--	--	1.6
19	40	1.22	1.22	2.53	3.09	40.00	--	--	1.3

Appendix 3. Continued

				Cost of Machinery			Fertilizer Use in Pounds Per Acre		
No.	Acres	Man Hours Per Acre	Use of Machinery Hours Per Acre	Variable Costs Per Hour	Variable Costs Per Acre	Cost of Twine	N	P	Alfalfa Yield Per Acre (Tons)
				$	$	$			
20	10	2.1	2.1	1.20	2.52	16.00	--	--	2.0
21	15	--	--	--	--	--	--	--	2.5
22	40	--	--	--	--	--	--	--	--
23	125	--	--	--	--	--	--	--	2.4
24	100	0.8	0.8	3.34	2.67	120.00	--	--	1.5
25	18	2.5	2.5	1.61	4.02	24.00	--	--	2.0
26	23	2.17	2.17	1.61	3.49	32.00	--	--	2.0
27	43	--	--	--	--	--	--	--	3.0
28	50	--	--	--	--	--	--	--	1.5
29	160	--	--	--	--	--	--	--	1.5
30	25	--	--	--	--	--	--	--	2.0
31	182	--	--	--	--	--	--	--	3.0
32	111	--	--	--	--	--	--	--	2.3
33	90	--	--	--	--	--	--	--	2.2
34	20	--	--	--	--	--	--	--	1.5
35	40	--	--	--	--	--	--	--	--

NOTE: The blanks under Man Hours Per Acre, Tractor Hours Per Acre, Tractor Costs Per Hour and Tractor Costs Per Acre indicate that the farmers had their harvest operations done for them.

Appendix 4(a). Tractor Costs in Establishing Alfalfa - County of Smoky Lake, 1974

No.	Tractor Make	H.P.	Acres	Total Man Hours	Total Tractor Hours	Man Hours Per Acre	Tractor Hours Per Acre	Tractor's Variable Costs/Hour	Tractor's Total Variable Cost	Tractor's Variable Costs/Acre	Tractor's Fixed Cost Per Hour	Tractor's Fixed Cost Per Acre	Tractor's Total Cost Per Acre
1	M.F.	120	56	57	57	1.14	1.14	3.74	213.18	4.25	2.14	2.44	6.70
2	Case	86	30	43	43	1.43	1.43	3.24	139.32	4.63	1.92	2.74	7.37
3	Case	78	80	180	150	2.25	1.87	2.22	333.00	4.15	1.88	3.51	7.66
4	M.F.	46	30	79	79	2.63	2.63	1.61	127.19	4.23	1.54	4.05	5.59
5	M.F.	63	30	28	28	0.93	0.93	1.78	49.84	1.65	1.81	1.68	3.33
6	M.F.	90	50	48	48	0.96	0.96	3.59	172.32	3.45	1.73	1.66	5.11
7	M.F.	46	125	230	230	1.84	1.84	1.61	370.30	2.96	1.54	2.83	5.79
8	M.F.	46	60	148	148	2.46	2.46	1.61	238.28	3.96	1.54	3.79	7.75
9	Allis	93	40	46	36	1.15	0.90	2.84	102.24	2.56	1.97	1.77	4.33
10	Int.	45	40	147	132	3.67	3.30	1.61	212.52	5.31	1.54	5.08	10.39
11	M.F.	120	35	59	59	1.68	1.68	3.74	220.66	6.28	2.14	3.60	9.88
12	Case	53	50	107	107	2.14	2.14	1.98	211.86	4.24	1.47	3.15	7.39
13	J. Deere	45	60	97	93	1.61	1.55	1.20	111.60	1.86	1.56	2.42	4.28
14	J. Deere	45	10	33	33	3.30	3.30	1.20	39.60	3.96	1.56	5.15	9.11
15	Case	53	30	49	49	1.63	1.63	1.98	97.02	3.23	1.47	2.40	5.63
16	J. Deere	45	44	148	148	3.36	3.36	1.20	177.60	4.03	1.56	5.24	9.27
17	Case	56	10	22	22	2.20	2.20	1.98	43.56	4.36	1.47	3.23	7.59
18	Case	56	30	98	98	3.26	3.26	1.98	194.04	6.45	1.47	4.79	11.24
19	M.F.	81	40	76	76	1.90	1.90	2.53	192.28	4.80	2.19	4.16	8.96
20	J. Deere	45	10	23	18	2.30	1.80	1.20	21.60	2.16	1.56	2.81	4.97
21	Way	65	15	32	24	3.66	1.60	1.78	42.72	2.84	1.81	2.90	5.74
22	Ford	110	40	95	95	2.37	2.37	3.34	317.30	7.93	2.18	5.17	13.10
23	J. Deere	45	125	295	295	2.36	2.36	1.20	354.00	2.83	1.56	3.68	6.51
24	Case	100	100	180	180	1.80	1.80	3.34	601.20	6.01	2.18	3.92	9.93
25	M.F.	46	18	45	45	2.50	2.50	1.61	72.45	4.02	1.54	3.85	7,87
26	M.F.	44	23	56	56	2.43	2.43	1.61	90.16	3.91	1.54	3.74	7.65
27	M.F.	37	43	110	110	2.55	2.55	1.31	144.10	3.34	1.27	3.24	6.58
28	Int.	36	50	80	80	1.60	1.60	1.61	128.80	2.58	1.54	2.46	5.04
29	Int.	45	160	306	306	1.91	1.91	1.31	400.86	2.50	1.27	2.42	4.92
30	Int.	45	25	87	87	3.48	3.48	1.61	140.07	5.60	1.54	5.36	10.96
31	J. Deere	45	182	212	212	1.16	1.16	1.20	254.40	1.39	1.56	1.81	3.20
32	J. Deere	45	111	255	255	2.29	2.29	1,20	306.00	2.75	1.56	3.57	6.32
33	J. Deere	45	90	96	96	1.06	1.06	1.20	115.20	1.27	1.56	1.65	2.92
34	J. Deere	45	20	35	35	1.75	1.75	1.20	42.00	2.10	1.56	2.73	4.83
35	Allis	89	40	73	73	1.82	1.82	3.24	236.52	5.90	1.92	3.49	9.39

Appendix 4(b). Production Expenses for Establishing Alfalfa: Smoky Lake County, 1974

		Cost of Seed		Cost of Fertilizer		Cost of Spray				
No.	Acres	Per Acre	Total	Per Acre	Total	Per Acre	Total	Other Inputs	Total Input Costs	Input Costs Per Acre
1	50	6.20	310.00	2.80	140.00	--	--	--	450.00	9.00
2	30	11.80	354.00	7.00	210.00	--	--	--	560.00	12.00
3	80	9.10	728.00	--	--	--	--	--	728.00	9.10
4	30	8.50	255.00	--	--	--	--	--	255.00	8.50
5	30	8.85	265.50	2.25	67.50	--	--	--	333.00	11.00
6	50	5.95	297.50	4.50	225.00	--	--	--	522.50	10.45
7	125	7.90	987.50	--	--	--	--	--	987.50	7.90
8	60	4.80	288.00	--	--	2.33	139.80	--	427.80	7.13
9	40	5.20	208.00	3.20	128.00	--	--	--	336.00	8.40
10	40	6.60	264.00	1.00	40.00	--	--	--	304.00	7.60
11	35	6.20	217.00	--	--	--	--	--	217.00	6.20
12	50	9.70	485.00	3.20	160.00	--	--	--	645.00	12.90
13	60	8.40	504.00	--	--	--	--	9.00	513.00	8.55
14	10	7.90	70.70	2.00	20.00	--	--	--	90.00	9.00
15	30	8.40	252.00	--	--	--	--	--	252.00	8.40
16	44	6.20	272.80	--	--	--	--	--	272.80	6.20
17	10	7.20	72.00	--	--	--	--	--	72.00	7.20
18	30	7.60	228.00	.50	15.00	--	--	--	243.00	8.10
19	40	7.30	292.00	1.20	48.00	--	--	--	340.00	8.50

Appendix 4(b). Continued

No.	Acres	Cost of Seed		Cost of Fertilizer		Cost of Spray		Other Inputs	Total Input Costs	Input Costs Per Acre
		Per Acre	Total	Per Acre	Total	Per Acre	Total			
20	10	9.70	97.00	--	--	--	--	62.50	159.50	15.95
21	15	7.20	108.00	--	--	--	--	--	108.00	7.20
22	40	8.70	348.00	--	--	--	--	--	348.00	8.70
23	125	8.50	1062.50	--	--	--	--	--	1062.50	8.50
24	100	7.50	750.00	1.50	150.00	--	--	--	900.00	9.00
25	18	7.70	138.60	1.50	27.00	--	--	--	165.60	9.20
26	23	7.70	176.10	2.00	46.00	--	--	--	222.10	9.65
27	43	8.75	376.75	--	--	--	--	--	376.75	8.75
28	50	7.30	365.00	1.60	80.00	--	--	--	445.00	8.90
29	160	9.20	1472.00	--	--	--	--	--	1472.00	9.20
30	25	5.80	145.00	2.00	50.00	--	--	--	195.00	7.80
31	182	9.80	1783.60	--	--	--	--	--	1783.60	9.80
32	111	7.60	843.60	1.20	133.20	--	--	--	976.80	8.80
33	90	7.20	648.00	--	--	--	--	--	648.00	7.20
34	20	8.50	170.00	--	--	--	--	--	170.00	8.50
35	40	6.10	244.00	2.80	112.00	--	--	--	356.00	8.90

NOTE: The blanks indicate that no fertilizer, spray or other inputs were used.

Appendix 4(c). Revenue Earned from the Sale of Cover Crop in the First Year of Growing Alfalfa - Smoky Lake County, 1974

No.	Acres	Yield Per Acre in Bushels				Total Production in Bushels	Price Per Bushel	Total Revenue	Gross Revenue Per Acre
		Oats	Barley	Wheat	Rapeseed				
1	50	75	--	--	--	3750	.50	1875.00	37.50
2	30	--	--	--	20	600	2.30	1380.00	46.00
3	80	--	--	20	--	1600	1.25	2000.00	25.00
4	30	--	40	--	--	1200	.80	960.00	32.00
5	30	--	--	30	--	900	1.25	1125.00	37.50
6	50	--	60	--	--	3000	.80	2400.00	48.00
7	125	--	--	30	--	3750	1.25	4887.50	39.10
8	60	55	--	--	--	3300	.50	1650.00	27.50
9	40	--	45	--	--	1800	.80	1440.00	36.00
10*	40	--	--	--	--	--	--	--	--
11	35	53	--	--	--	1855	.50	927.50	26.50
12	50	--	38	--	--	1900	.80	1520.00	30.40
13	60	50	--	--	--	3000	.50	1500.00	25.00
14	10	--	40	--	--	400	.80	320.00	32.00
15	30	53	--	--	--	1590	.50	795.00	26.50
16	44	56	--	--	--	2464	.50	1232.00	28.00
17	10	50	--	--	--	500	.50	250.00	25.00
18	30	--	--	25	--	750	1.25	937.50	31.25
19	40	--	38	--	--	1520	.80	1216.00	30.40

Appendix 4(c). Continued

No.	Acres	Yield Per Acre in Bushels				Total Production in Bushels	Price Per Bushel	Total Revenue	Gross Revenue Per Acre
		Oats	Barley	Wheat	Rapeseed				
20	10	--	--	28	--	280	1.25	350.00	35.00
21	15	53	--	--	--	795	.50	397.50	26.50
22	40	--	--	--	--	--	--	--	--
23	125	--	40	--	--	5000	.80	4000.00	32.00
24	100	--	30	--	--	3000	.80	2400.00	24.00
25	18	--	30	--	--	540	.80	432.00	24.00
26	23	--	--	--	15	345	2.30	793.50	34.50
27	43	--	--	40	--	1720	1.25	2150.00	50.00
28	50	--	45	--	--	2250	.80	1800.00	36.00
29	160	--	35	--	--	5600	.80	4480.00	28.00
30	25	--	50	--	--	1250	.80	1000.00	40.00
31	182	60	--	--	--	10920	.50	5460.00	30.00
32	111	--	30	--	--	3330	.80	2664.00	24.00
33*	90	--	--	--	--	--	--	--	--
34	20	--	30	--	--	600	.80	480.00	24.00
35	40	--	40	--	--	1600	.80	1280.00	32.00

* There was no cover crop recorded.

Appendix 4(d). Costs and Returns on Per Acre Basis in the First Year of Growing Alfalfa - Smoky Lake County, 1974

No.	Revenue	Tractor's Total Variable Costs	Total Cost of Inputs	Total Variable Costs	Gross Margin	Gross Revenue Per Acre	Tractor's Total Variable Costs/Acre	Total Cost of Inputs Per Acre	Total Variable Costs/Acre	Gross Margin Per Acre	Tractor's Total Fixed Costs/Acre	Net Margin Per Acre
1	1875.00	213.18	450.00	663.18	1211.02	37.50	4.26	9.00	13.26	24.24	2.44	21.80
2	1380.00	139.32	560.00	699.32	680.68	46.00	4.63	12.00	16.63	29.37	2.74	26.63
3	2000.00	333.00	728.00	1061.00	938.00	25.00	4.15	9.10	13.25	11.75	3.51	8.24
4	960.00	127.19	255.00	382.19	577.81	32.00	4.23	8.50	12.73	19.27	4.05	15.22
5	1125.00	49.84	333.00	382.84	742.16	37.50	1.65	11.00	12.65	24.85	1.68	23.17
6	2400.00	172.32	522.50	694.82	1705.18	48.00	3.45	10.45	13.90	34.10	1.66	32.44
7	4887.50	370.30	987.50	1357.80	3529.70	39.10	2.96	7.90	10.86	28.24	2.83	25.41
8	1650.00	238.28	427.80	666.08	983.92	27.50	3.96	7.13	11.09	16.41	3.79	12.62
9	1440.00	102.24	336.00	438.24	1001.76	36.00	3.56	8.40	11.96	24.04	1.77	22.27
10*	--	212.52	304.00	516.52	-516.52	--	5.31	7.60	12.91	-12.91	5.08	-17.99
11	927.50	220.66	217.00	437.66	489.84	26.50	6.28	6.20	12.48	14.02	3.60	10.42
12	1520.00	211.86	645.00	856.86	663.14	30.40	4.24	12.90	17.14	13.26	3.15	10.11
13	1500.00	111.60	513.00	624.60	875.40	25.00	1.86	8.55	10.41	14.59	2.42	12.17
14	320.00	39.60	90.00	129.60	190.40	32.00	3.96	9.00	12.96	19.04	5.15	13.89
15	795.00	97.02	252.00	349.02	445.98	26.50	3.23	8.40	11.63	14.87	2.40	12.47
16	1232.00	177.60	272.80	450.40	781.60	28.00	4.03	6.20	10.23	17.77	5.24	12.53
17	250.00	43.56	72.00	115.56	134.44	25.00	4.36	7.20	11.56	13.44	3.23	10.21
18	937.50	194.04	243.00	437.04	500.46	31.25	6.45	8.10	14.55	16.70	4.79	11.91
19	1216.00	192.28	340.00	532.28	683.72	30.40	4.80	8.50	13.30	17.10	4.16	12.94
20	350.00	21.60	159.50	181.10	168.90	35.00	2.16	15.95	18.11	16.89	2.81	14.08
21	397.50	42.72	108.00	150.72	246.78	26.50	2.80	7.20	10.04	16.46	2.90	13.56
22*	--	317.30	348.00	665.30	-665.30	--	7.93	8.70	16.63	-16.63	5.17	-21.80
23	4000.00	354.00	1062.50	1416.50	2583.50	32.00	2.83	8.50	11.33	20.67	3.68	16.99
24	2400.00	601.20	900.00	1501.20	898.80	24.00	6.01	9.00	15.01	8.99	3.92	5.07
25	432.00	72.45	165.60	238.05	193.95	24.00	4.02	9.20	13.22	10.78	3.85	6.93
26	793.50	90.16	222.10	312.26	481.24	34.50	3.91	9.65	13.56	20.94	3.74	17.20
27	2150.00	144.10	376.75	520.85	1629.15	50.00	3.34	8.75	12.09	37.91	3.24	34.67
28	1800.00	128.80	445.00	573.80	1226.20	36.00	2.58	8.90	11.48	24.52	2.46	22.06
29	4480.00	400.86	1472.00	1872.86	2607.14	28.00	2.50	9.20	11.70	16.30	2.42	13.88
30	1000.00	140.07	195.00	335.07	664.93	40.00	5.60	7.80	13.40	26.60	5.36	21.24
31	5460.00	254.40	1783.60	2038.00	3422.00	30.00	1.39	9.80	11.19	18.81	1.81	17.00
32	2664.00	306.00	976.80	1282.80	1381.20	24.00	2.75	8.80	11.55	12.45	1.57	10.88
33*	--	115.20	648.00	763.20	-763.20	--	1.27	7.20	8.47	-8.47	1.65	-10.12
34	480.00	42.00	170.00	212.00	268.00	24.00	2.10	8.50	10.60	13.40	2.73	10.67
35	1280.00	236.52	356.00	592.52	687.48	32.00	5.90	8.90	14.80	17.20	3.49	13.71

* No revenue was obtained from the sale of cover crop.

Appendix 5(a). Tractor Costs for the Maintenance of Alfalfa in the Second Year - Smoky Lake County, 1974

No.	Acres	Total Man Hours	Total Tractor Hours	Man Hours Per Acre	Tractor Hours Per Acre	Tractor's Variable Costs Per Hour	Tractor's Total Variable Costs	Tractor's Total Variable Costs Per Acre	Tractor's Total Fixed Costs/Hour	Tractor's Total Fixed Cost Per Acre	Tractor's Total Costs Per Acre
1	50	120	120	2.40	2.40	3.74	448.80	8.97	2.14	5.14	14.11
2	30	111	27	3.70	0.90	3.24	87.48	2.92	1.92	1.73	4.65
3	80	115	115	1.43	1.43	2.22	255.30	3.17	1.88	2.69	5.86
4	30	55	55	1.83	1.83	1.61	88.55	2.95	1.54	2.82	5.77
5	30	72	72	2.40	2.40	1.78	128.16	4.27	1.81	4.34	8.61
6	50	40	40	0.80	0.80	3.59	143.60	2.87	1.73	1.38	4.25
7	125	230	230	1.84	1.84	1.61	370.30	2.96	1.54	2.83	5.79
8	60	125	125	2.08	2.08	1.61	201.25	3.35	1.54	3.20	6.55
9	40	42	32	1.05	0.80	2.84	90.88	2.27	1.97	1.58	3.85
10	40	70	70	1.75	1.75	1.61	112.70	2.82	1.54	2.69	5.51
11	35	50	50	1.42	1.42	3.74	187.00	5.31	2.14	3.04	8.35
12	50	90	90	1.80	1.80	1.98	178.20	3.56	1.47	2.65	6.21
13	60	78	78	1.30	1.30	1.20	93.60	1.56	1.56	2.03	3.59
14	10	11	11	1.10	1.10	1.20	13.20	1.32	1.56	1.72	3.04
15	30	67	67	2.27	1.27	1.98	132.66	4.49	1.47	3.34	7.83
16	44	97	97	2.20	2.20	1.20	116.40	2.64	1.56	3.43	6.07
17	10	30	30	3.30	3.30	1.98	59.40	6.53	1.47	4.85	11.38
18	30	56	56	1.86	1.86	1.98	110.88	3.68	1.47	2.73	6.41
19	40	49	49	1.22	1.22	2.53	123.97	3.09	2.19	2.67	5.76
20	10	21	21	2.10	2.10	1.20	25.20	2.52	1.56	3.28	5.80
21	15	27	21	1.80	1.40	1.78	37.38	2.49	1.81	2.53	5.02
22	40	30	30	0.75	0.75	3.34	100.20	2.50	2.18	1.63	4.13
23	125	102	102	0.81	0.81	1.20	122.40	0.97	1.56	1.26	2.23
24	100	80	80	0.80	0.80	3.34	267.20	2.67	2.18	1.74	4.41
25	18	27	27	1.50	1.50	1.61	43.47	2.41	1.54	2.31	4.72
26	23	46	46	2.00	2.00	1.61	74.06	3.22	1.54	3.08	6.30
27	43	110	110	2.55	2.55	1.31	144.10	3.34	1.27	3.24	6.58
28	50	--	--	--	--	--	--	--	--	--	--
29	160	--	--	--	--	--	--	--	--	--	--
30	25	--	--	--	--	--	--	--	--	--	--
31	182	--	--	--	--	--	--	--	--	--	--
32	111	--	--	--	--	--	--	--	--	--	--
33	90	--	--	--	--	--	--	--	--	--	--
34	20	--	--	--	--	--	--	--	--	--	--
35	40	--	--	--	--	--	--	--	--	--	--

NOTE: The blanks indicate that field operations were not done by the farmer.

Appendix 5(b). Production Expenses in the Second Year of Maintaining Alfalfa - The County of Smoky Lake, 1974

No.	Acres	Cost of Fertilizer Per Acre	Cost of Fertilizer Total	Cost of Twine	Cost of Other Inputs	Total Variable Costs	Variable Total Per Acre
1	50	--	--	63.00	--	63.00	1.26
2	30	--	--	49.00	--	49.00	1.63
3	80	--	--	84.00	--	84.00	1.05
4	30	--	--	42.00	--	42.00	1.40
5	30	--	--	42.00	--	42.00	1.40
6	50	--	--	56.00	--	56.00	1.12
7	125	1.37	171.25	63.00	--	234.25	1.87
8	60	--	--	63.00	--	63.00	1.05
9	40	--	--	42.00	21.00	63.00	1.57
10	40	--	--	49.00	72.00	121.00	3.02
11	35	1.60	56.00	35.00	--	91.00	2.60
12	50	--	--	42.00	60.00	102.00	2.04
13	60	3.00	180.00	28.00	--	208.00	3.46
14	10	1.60	16.00	14.00	--	30.00	3.00
15	30	--	--	35.00	--	35.00	1.16
16	44	--	--	42.00	--	42.00	0.95
17	10	--	--	14.00	--	14.00	1.40
18	30	--	--	28.00	--	28.00	0.93
19	40	--	--	28.00	--	28.00	0.70

Appendix 5(b). Continued

No.	Acres	Cost of Fertilizer Per Acre	Cost of Fertilizer Total	Cost of Twine	Cost of Other Inputs	Total Variable Costs	Variable Total Per Acre
20	10	--	--	14.00	20.00	34.00	3.40
21	15	--	--	21.00	36.00	57.00	3.80
22	40	--	--	42.00	--	42.00	1.05
23	125	--	--	105.00	--	105.00	0.84
24	100	--	--	70.00	--	70.00	0.70
25	18	--	--	14.00	--	14.00	0.77
26	23	--	--	21.00	--	21.00	0.91
27	43	--	--	56.00	--	56.00	1.30
28	50	--	--	--	--	--	--
29	160	--	--	--	--	--	--
30	25	--	--	--	--	--	--
31	182	--	--	--	--	--	--
32	111	--	--	--	--	--	--
33	90	1.60	144.00	--	--	144.00	1.60
34	20	--	--	--	--	--	--
35	40	--	--	--	--	--	--

NOTE: The blanks indicate that no cost on fertilizer, spray and other inputs was incurred.

Appendix 5(c). Revenue Earned from the Sale of Alfalfa in the Second Year - Smoky Lake County, 1974

No.	Acres	Tons of Yield Per Acre	Total Tons	Price Per Ton	Total Revenue	Gross Revenue Per Acre
1	50	1.5	75	20.00	1500.00	30.00
2	30	3.0	90	20.00	1800.00	60.00
3	80	1.5	120	20.00	2400.00	30.00
4	30	2.0	60	20.00	1200.00	40.00
5	30	2.0	60	20.00	1200.00	40.00
6	50	1.5	75	20.00	1500.00	30.00
7	125	1.6	200	20.00	4000.00	32.00
8	60	1.5	90	20.00	1800.00	30.00
9	40	1.5	60	20.00	1200.00	30.00
10	40	1.8	76	20.00	1520.00	38.00
11	35	2.0	70	20.00	1400.00	40.00
12	50	1.5	75	20.00	1500.00	30.00
13	60	1.5	90	20.00	1800.00	30.00
14	10	1.5	15	20.00	300.00	30.00
15	30	1.5	45	20.00	900.00	30.00
16	44	1.5	66	20.00	1320.00	30.00
17	10	1.5	15	20.00	300.00	30.00
18	30	1.6	48	20.00	960.00	32.00
19	40	1.3	52	20.00	1040.00	26.00
20	10	1.5	15	20.00	300.00	30.00
21	15	2.0	30	18.00	540.00	36.00
22	40	1.5	60	18.00	1080.00	27.00
23	125	1.5	187.5	18.00	3375.00	27.00
24	100	1.5	150	18.00	2700.00	27.00
25	18	1.5	27	18.00	486.00	27.00
26	23	1.5	34.5	18.00	621.00	27.00
27	43	2.0	86	18.00	1548.00	36.00
28	50	1.5	75	18.00	1350.00	27.00
29	160	1.5	240	18.00	4320.00	27.00
30	25	2.0	50	18.00	900.00	36.00
31	182	2.0	364	18.00	6552.00	36.00
32	111	1.8	199.8	18.00	3596.40	32.40
33	90	2.3	207	18.00	3726.00	41.40
34	20	1.5	30	18.00	540.00	27.00
35	40	1.5	60	18.00	1080.00	27.00

Appendix 5(d). Costs and Returns on Per Acre Basis in the Second Year of Maintaining Alfalfa - County of Smoky Lake, 1974

No.	Gross Revenue	Tractor's Total Variable Costs	Total Cost of Inputs	Total Variable Costs	Gross Margin	Gross Revenue Per Acre	Tractor's Total Variable Costs Per Acre	Total Cost of Inputs Per Acre	Total Variable Costs Per Acre	Gross Margin Per Acre	Tractor's Total Fixed Costs/Acre	Net Margin Per Acre
1	1500.00	448.80	63.00	511.80	988.20	30.00	8.97	1.26	10.23	19.77	5.14	14.63
2	1800.00	87.48	49.00	136.48	1663.52	60.00	2.92	1.63	4.55	55.45	1.73	53.72
3	2400.00	255.30	84.00	339.30	2060.70	30.00	3.17	1.05	4.22	25.78	2.69	23.09
4	1200.00	88.55	42.00	130.55	1069.45	40.00	2.95	1.40	4.35	35.65	2.82	32.83
5	1200.00	128.16	42.00	170.16	1029.84	40.00	4.27	1.40	5.67	34.33	4.34	29.99
6	1500.00	143.60	56.00	199.60	1300.40	30.00	2.87	1.12	3.99	26.01	1.38	24.63
7	4000.00	370.30	234.25	604.55	3395.45	32.00	2.96	1.87	4.83	27.17	2.83	24.34
8	1800.00	201.25	63.00	264.25	1535.75	30.00	3.35	1.05	4.40	25.60	3.20	22.40
9	1200.00	90.88	63.00	153.88	1041.12	30.00	2.27	1.57	3.84	26.16	1.58	24.58
10	1520.00	112.70	121.00	233.70	1286.30	38.00	2.82	3.02	5.84	32.16	2.69	29.47
11	1400.00	187.00	91.00	278.00	1122.00	40.00	5.31	2.60	7.91	32.09	3.04	29.05
12	1500.00	178.20	102.00	280.20	1219.80	30.00	3.56	2.04	5.60	24.40	2.65	21.75
13	1800.00	93.60	208.00	301.60	1498.40	30.00	1.56	3.46	5.02	24.98	2.03	22.95
14	300.00	13.20	30.00	43.20	256.80	30.00	1.32	3.00	4.32	25.68	1.72	23.96
15	900.00	132.66	35.00	167.66	732.34	30.00	4.49	1.16	5.65	24.35	3.34	21.01
16	1320.00	116.40	42.00	158.40	1161.60	30.00	2.64	0.95	3.59	26.41	3.43	22.98
17	300.00	59.40	14.00	73.40	226.60	30.00	6.53	1.40	7.93	22.07	4.85	17.22
18	960.00	110.88	28.00	138.88	821.12	32.00	3.68	0.93	4.61	27.39	2.73	24.66
19	1040.00	123.97	28.00	151.97	888.03	26.00	3.09	0.70	3.79	22.21	2.67	19.54
20	300.00	25.20	34.00	59.20	240.80	30.00	2.52	3.40	5.92	24.08	3.28	20.80
21	540.00	37.38	57.00	94.38	445.62	36.00	2.49	3.80	6.28	29.72	2.53	27.19
22	1080.00	100.20	42.00	142.20	937.80	27.00	2.50	1.05	3.55	23.45	1.63	21.82
23	3375.00	122.40	105.00	227.40	3147.60	27.00	0.97	0.84	1.81	25.19	1.26	23.93
24	2700.00	267.20	70.00	337.20	2362.80	27.00	2.67	0.70	3.37	23.63	1.74	21.89
25	486.00	43.47	14.00	57.47	428.53	27.00	2.41	0.77	3.18	23.82	2.31	21.51
26	621.00	74.06	21.00	95.06	525.94	27.00	3.22	0.91	4.13	22.87	3.08	19.79
27	1548.00	144.10	56.00	200.10	1347.90	36.00	3.34	1.30	4.64	31.36	3.24	28.12
28	1350.00	--	--	--	1350.00	27.00	--	--	--	27.00	--	27.00
29	4320.00	--	--	--	4320.00	27.00	--	--	--	27.00	--	27.00
30	900.00	--	--	--	900.00	36.00	--	--	--	36.00	--	36.00
31	6552.00	--	--	--	6552.00	36.00	--	--	--	36.00	--	36.00
32	3596.00	--	--	--	3596.00	32.40	--	--	--	32.40	--	32.40
33	3726.00	--	--	--	3726.00	41.40	--	1.60	1.60	39.80	--	39.80
34	540.00	--	--	--	540.00	27.00	--	--	--	27.00	--	27.00
35	1080.00	--	--	--	1080.00	27.00	--	--	--	27.00	--	27.00

NOTE: The blanks indicate that no cost was incurred by the farmer.

Appendix 6(a). Tractor Costs for the Maintenance of Alfalfa in the Third Year - County of Smoky Lake, 1974

No.	Acres	Total Man Hours	Total Tractor Hours	Man Hours Per Acre	Tractor Hours Per Acre	Tractor's Total Variable Costs/Hour	Tractor's Total Variable Costs	Tractor's Total Variable Costs Per Acre	Tractor's Total Fixed Costs/Hour	Tractor's Total Fixed Costs Per Acre	Tractor's Total Costs Per Acre
1	50	120	120	2.40	2.40	3.74	448.80	8.97	2.14	5.14	14.11
2	30	122	27	4.06	0.90	3.24	87.48	2.92	1.92	1.73	4.65
3	80	115	115	1.43	1.43	2.22	255.30	3.17	1.88	2.69	5.86
4	30	55	55	1.83	1.83	1.61	88.55	2.95	1.54	2.82	5.77
5	30	72	72	2.40	2.40	1.78	128.16	4.27	1.81	4.34	8.61
6	50	40	40	0.80	0.80	3.59	143.60	2.87	1.73	1.38	4.25
7	125	230	230	1.84	1.84	1.61	370.30	2.96	1.54	2.83	5.79
8	60	120	40	2.00	0.66	1.61	64.40	1.06	1.54	1.02	2.08
9	40	62	32	1.55	0.80	2.84	90.88	2.27	1.97	1.58	3.85
10	40	58	58	1.45	1.45	1.61	93.38	2.33	1.54	2.23	4.56
11	35	50	50	1.42	1.42	3.74	187.00	5.31	2.14	3.04	8.35
12	50	80	80	1.60	1.60	1.98	158.40	3.17	1.47	2.35	5.52
13	60	78	78	1.30	1.30	1.20	93.60	1.56	1.56	2.03	3.59
14	10	11	11	1.10	1.10	1.20	13.20	1.32	1.56	1.72	3.04
15	30	67	67	2.23	2.23	1.98	132.66	4.41	1.47	3.28	7.69
16	44	97	97	2.20	2.20	1.20	116.40	2.64	1.56	3.43	6.07
17	10	50	50	5.00	5.00	1.98	99.00	9.90	1.47	7.35	17.25
18	30	67	67	2.23	2.23	1.98	132.66	4.41	1.47	3.28	7.69
19	40	49	49	1.22	1.22	2.53	123.97	3.09	2.19	2.67	5.76
20	10	21	21	2.10	2.10	1.20	25.20	2.52	1.56	3.28	5.80
21	15	--	--	--	--	--	--	--	--	--	--
22	40	--	--	--	--	--	--	--	--	--	--
23	125	--	--	--	--	--	--	--	--	--	--
24	100	80	80	0.80	0.80	3.34	26.72	2.67	2.18	1.74	4.41
25	18	45	45	2.50	2.50	1.61	72.45	4.02	1.54	3.86	7.87
26	23	50	50	2.17	2.17	1.61	80.50	3.49	1.54	3.34	6.83
27	43	--	--	--	--	--	--	--	--	--	--
28	50	--	--	--	--	--	--	--	--	--	--
29	160	--	--	--	--	--	--	--	--	--	--
30	25	--	--	--	--	--	--	--	--	--	--
31	182	--	--	--	--	--	--	--	--	--	--
32	111	--	--	--	--	--	--	--	--	--	--
33	90	--	--	--	--	--	--	--	--	--	--
34	20	--	--	--	--	--	--	--	--	--	--
35	40	--	--	--	--	--	--	--	--	--	--

NOTE: The blanks indicate that field operations were not carried out by the farmer.

Appendix 6(b). Production Expenses in the Third Year of Maintaining Alfalfa - County of Smoky Lake, 1974

No.	Acres	Cost of Fertilizer		Cost of Spray		Cost of Twine	Other Inputs	Total Cost	Cost Per Acre
		Per Acre	Total	Per Acre	Total				
1	50	--	--	--	--	56.00	--	56.00	1.12
2	30	--	--	--	--	64.00	--	64.00	2.13
3	80	--	--	--	--	96.00	--	96.00	1.20
4	30	1.60	48.00	--	--	80.00	--	128.00	4.26
5	30	--	--	--	--	64.00	--	64.00	2.13
6	50	--	--	--	--	56.00	--	56.00	1.12
7	125	--	--	--	--	160.00	--	160.00	1.28
8	60	--	--	--	--	72.00	20.00	92.00	1.53
9	40	--	--	--	--	48.00	20.00	68.00	1.70
10	40	--	--	--	--	64.00	9.00	73.00	1.82
11	35	1.60	56.00	--	--	40.00	--	96.00	2.74
12	50	--	--	--	--	56.00	--	56.00	1.12
13	60	1.50	90.00	--	--	72.00	--	162.00	2.70
14	10	--	--	--	--	16.00	--	16.00	1.60
15	30	--	--	--	--	32.00	--	32.00	1.06
16	44	--	--	--	--	48.00	--	48.00	1.09
17	10	--	--	--	--	16.00	--	16.00	1.60
18	30	--	--	--	--	32.00	--	32.00	1.06
19	40	--	--	--	--	40.00	--	40.00	1.00

Appendix 6(b). Continued

No.	Acres	Cost of Fertilizer Per Acre	Total	Cost of Spray Per Acre	Total	Cost of Twine	Other Inputs	Total Cost	Cost Per Acre
20	10	--	--	--	--	16.00	--	16.00	1.60
21	15	--	--	--	--	--	--	--	--
22	40	--	--	--	--	--	--	--	--
23	125	--	--	--	--	--	--	--	--
24	100	--	--	--	--	120.00	--	120.00	1.20
25	18	--	--	--	--	24.00	--	24.00	1.33
26	23	--	--	--	--	32.00	--	32.00	1.39
27	43	--	--	--	--	--	--	--	--
28	50	--	--	--	--	--	--	--	--
29	160	--	--	--	--	--	--	--	--
30	25	--	--	--	--	--	--	--	--
31	182	--	--	--	--	--	--	--	--
32	111	--	--	--	--	--	--	--	--
33	90	--	--	--	--	--	--	--	--
34	20	--	--	--	--	--	--	--	--
35	40	--	--	--	--	--	--	--	--

NOTE: The blanks indicate that no cost on fertilizer ,spray and other inputs was incurred.

Appendix 6(c). Revenue Earned from Sale of Alfalfa in the Third Year - County of Smoky Lake, 1974

No.	Acres	Yield Per Acre in Tons	Total Tons	Price Per Ton	Gross Total Revenue	Gross Revenue Per Acre
1	50	1.5	75	24.00	1800.00	36.00
2	30	2.5	75	24.00	1800.00	60.00
3	80	2.0	160	24.00	3840.00	48.00
4	30	3.0	90	24.00	2160.00	72.00
5	30	2.5	75	24.00	1800.00	60.00
6	50	1.5	75	24.00	1800.00	36.00
7	125	2.0	250	24.00	6000.00	48.00
8	60	1.5	90	24.00	2160.00	36.00
9	40	1.5	60	24.00	1440.00	36.00
10	40	2.0	80	24.00	1920.00	48.00
11	35	1.5	52.5	24.00	1260.00	36.00
12	50	1.5	75	24.00	1800.00	36.00
13	60	1.5	90	24.00	2160.00	36.00
14	10	2.0	20	24.00	480.00	48.00
15	30	1.5	45	24.00	1080.00	36.00
16	44	1.5	66	24.00	1584.00	36.00
17	10	2.0	20	24.00	480.00	48.00
18	30	1.6	48	24.00	1152.00	38.40
19	40	1.3	52	24.00	1248.00	31.20
20	10	2.0	20	24.00	480.00	48.00
21	15	2.5	37.5	22.00	825.00	55.00
22*	40	--	--	--	--	--
23	125	2.4	300	22.00	6600.00	52.80
24	100	1.5	150	22.00	3300.00	33.00
25	18	2.0	36	22.00	792.00	44.00
26	23	2.0	46	22.00	1012.00	44.00
27	43	3.0	129	22.00	2838.00	66.00
28	50	1.5	75	22.00	1650.00	33.00
29	160	1.5	240	22.00	5280.00	33.00
30	25	2.0	50	22.00	1100.00	44.00
31	182	3.0	546	22.00	12012.00	66.00
32	111	2.3	255.3	22.00	5616.60	50.60
33	90	2.2	198	22.00	4356.00	48.40
34	20	1.5	30	22.00	660.00	33.00
35*	40	--	--	--	--	--

* No yields or revenue was obtained from alfalfa sale.

Appendix 6(d) Costs and Returns on Per Acre Basis in the Third Year of Maintaining Alfalfa - County of Smoky Lake, 1974

No.	Gross Revenue	Tractor's Total Variable Costs	Total Cost of Inputs	Total Variable Costs	Gross Margin	Gross Revenue Per Acre	Tractor's Total Variable Costs Per Acre	Total Costs of Inputs Per Acre	Total Variable Costs Per Acre	Gross Margin Per Acre	Tractor's Total Fixed Costs/Acre	Net Margin Per Acre
1	1800.00	448.80	56.00	504.80	1295.20	36.00	8.97	1.12	10.09	25.19	5.14	20.77
2	1800.00	87.48	64.00	151.48	1648.52	60.00	2.92	3.12	5.05	54.95	1.73	53.22
3	3840.00	255.30	96.00	351.30	3488.70	48.00	3.17	1.20	4.37	43.63	2.69	40.94
4	2160.00	88.55	128.00	216.55	1943.45	72.00	2.95	4.26	7.21	64.79	2.82	61.97
5	1800.00	128.16	64.00	192.16	1607.84	60.00	4.27	2.13	6.40	53.60	4.34	49.26
6	1800.00	143.60	56.00	199.60	1600.40	36.00	2.87	1.12	3.99	32.01	1.38	30.63
7	6000.00	370.30	160.00	530.30	5469.70	48.00	2.96	1.28	4.24	43.76	2.83	40.93
8	2160.00	64.40	92.00	156.40	2003.60	36.00	1.06	1.53	2.59	33.41	1.02	32.39
9	1440.00	90.88	68.00	158.88	1281.12	36.00	2.27	1.70	3.97	32.03	1.58	30.45
10	1920.00	93.38	73.00	166.38	1753.62	48.00	2.33	1.82	4.15	43.85	2.23	41.62
11	1260.00	187.00	96.00	283.00	977.00	36.00	5.31	2.74	8.05	27.95	3.04	24.91
12	1800.00	158.40	56.00	214.40	1585.60	36.00	3.17	1.12	4.29	31.74	2.35	29.40
13	2160.00	93.60	162.00	255.60	1904.40	36.00	1.56	2.70	4.26	31.74	2.03	29.71
14	480.00	13.20	16.00	29.20	450.80	48.00	1.32	1.60	2.92	45.08	1.72	43.36
15	1080.00	132.66	32.00	164.66	915.34	36.00	4.41	1.06	5.47	30.53	3.28	27.25
16	1584.00	116.40	48.00	164.40	1419.60	36.00	2.64	1.09	3.73	32.27	3.43	28.84
17	480.00	99.00	16.00	115.00	365.00	48.00	9.90	1.60	11.50	36.50	7.35	29.15
18	1152.00	132.66	32.00	164.66	987.34	38.40	4.41	1.06	5.47	32.93	3.28	29:65
19	1248.00	123.97	40.00	163.97	1084.03	31.20	3.09	1.00	4.09	27.11	2.67	24.44
20	480.00	25.20	16.00	41.20	438.80	48.00	2.52	1.60	4.12	43.88	3.28	40.60
21	825.00	--	--	--	825.00	55.00	--	--	--	55.00	--	55.00
22*	--	--	--	--	--	--	--	--	--	--	--	--
23	6600.00	--	--	--	6600.00	52.80	--	--	--	52.80	--	52.80
24	3300.00	--	--	--	3300.00	33.00	--	--	--	33.00	--	33.00
25	792.00	--	--	--	792.00	44.00	--	--	--	44.00	--	44.00
26	1012.00	--	--	--	1012.00	44.00	--	--	--	44.00	--	44.00
27	2838.00	--	--	--	2838.00	66.00	--	--	--	66.00	--	66.00
28	1650.00	--	--	--	1650.00	33.00	--	--	--	33.00	--	33.00
29	5280.00	--	--	--	5280.00	33.00	--	--	--	33.00	--	33.00
30	1100.00	--	--	--	1100.00	44.00	--	--	--	44.00	--	44.00
31	12012.00	--	--	--	12012.00	66.00	--	--	--	66.00	--	66.00
32	5616.60	--	--	--	5616.60	50.60	--	--	--	50.60	--	50.60
33	4356.00	--	--	--	4356.00	48.40	--	--	--	48.40	--	48.40
34	660.00	--	--	--	660.00	33.00	--	--	--	33.00	--	33.00
35	--	--	--	--	--	--	--	--	--	--	--	--

* No revenue was recorded.

NOTE: The blanks indicate that field operations were not done by the farmer.

Appendix 7: Technology Model for Northern Alberta: Column Activity Prices and Cost Figures (RCF), Smoky Lake County and Census Division 15

Column Activity	Figure Used ($)	Source
BLY 1+2F	1.74 per acre	Cash expenditure, primary data, CD 15
BLY 1+25	1.74 per acre	Cash expenditure, primary data, CD 15
BLY 3F	1.74 per acre	Cash expenditure, primary data, CD 15
BLY 3S	1.74 per acre	Cash expenditure, primary data, CD 15
BLY 4F	1.74 per acre	Cash expenditure, primary data, CD 15
BLY 4S	1.74 per acre	Cash expenditure, primary data, CD 15
OAT 1+2F	3.11 per acre	Cash expenditure, primary data, CD 15
OAT 1+25	3.11 per acre	Cash expenditure, primary data, CD 15
OAT 3F	3.11 per acre	Cash expenditure, primary data, CD 15
OAT 3S	3.11 per acre	Cash expenditure, primary data, CD 15
OAT 4F	3.11 per acre	Cash expenditure, primary data, CD 15
OAT 4S	3.11 per acre	Cash expenditure, primary data, CD 15
RAP 1+2F	2.12 per acre	Cash expenditure, primary data, CD 15
RAP 1+2S	2.12 per acre	Cash expenditure, Primary data, CD 15
RAP 3F	2.12 per acre	Cash expenditure, primary data, CD 15
RAP 3S	2.12 per acre	Cash expenditure, primary data, CD 15
RAP 4F	2.12 per acre	Cash expenditure, primary data, CD 15
RAP 4S	2.12 per acre	Cash expenditure, primary data, CD 15
WHT 1+2F	2.30 per acre	Cash expenditure, primary data, CD 15
WHT 1+2S	2.30 per acre	Cash expenditure, priamry data, CD 15
WHT 3F	2.30 per acre	Cash expenditure, primary data, CD 15
WHT 3S	2.30 per acre	Cash expenditure, primary data, CD 15
WHT 4F	2.30 per acre	Cash expenditure, priamry data, CD 15
WHT 4S	2.30 per acre	Cash expenditure, primary data, CD 15

Appendix 7. Continued.

Column Activity	Figure Used ($)	Source
A-EST-1	2.59 per acre	Cash expenditure, primary data, Smoky Lake County
A-PR-1	1.56 per acre	Cash expenditure, primary data, Smoky Lake County.
ALFA-SL	50.00 per ton	Price assumed for alfalfa seed.
A-EST-1	2.59 per acre	Cash expenditure, primary data, Smoky Lake County.
A-PR-1	nil per acre	Cash expenditure, primary data, Smoky Lake County
ALFA-SP	48.00 per ton	Price assumed for alfalfa for plant.
N-FERT	29.40 per ton	ADA 1975 component price.
P-FERT	29.40 per ton	ADA 1975 component price.
K-FERT	36.60 per ton	ADA 1975 component price.
LTR-SR	.96 per hour	Fuel and repairs, primary data CD,15
MTR-SR	.61 per hour	Fuel and repairs, primary data CD,15
STR-SR	.39 per hour	Fuel and repairs, primary data CD,15
SWA-SR	5.39 per hour	Fuel and repairs, primary data CD,15
COM-SR	14.70 per hour	Fuel and repairs, primary data CD 15
LTR-PR	180.00 per tractor	Cash down payment, 10 yr. Amortization
MTR-PR	140.00 per tractor	Cash down payment, 10 yr. Amortization
STR-PR	80.00 per tractor	Cash down payment, 10 yr. Amortization.
SWA-PR	80.00 per swather	Cash downpayment , 10 yr. Amortization
COM-PR	200.00 per combine	Cash down payment, 10 yr. Amortization
BRY-SL	109.58 per ton	ADA, 1974 average price
OAT-SL	87.65 per ton	ADA, 1974 average price
RAP-SL	282.50 per ton	ADA, 1974 average price
WHT-SL	129.28 per ton	ADA, 1974 average price

Appendix 7. Continued

Column Activity	Figure Used ($)	Source
STR-GR	1.08 per ton	Grainery value (primary data,CD 15) 20 yr. Amortization.
STR-HY	.50 per cwt.	Hay shed value (primary data,CD 15) 20 yr. Amortization.
BRY-SD	8.22 per cwt.	Estimated seed cost.
OAT-SD	6.57 per cwt.	Estimated seed cost.
RAP-SD	21.19 per cwt.	Estimated seed cost.
WHT-SD	9.66 per cwt.	Estimated seed cost.
WCOW-1	30.00 per a/u	Cash expenditure, primary data, CD 15
WCOW-2	30.45 per a/u	Cash expenditure, primary data, CD 15
WCOW-3	32.89 per a/u	Cash expenditure, primary data, CD 15
WCAF-1	25.00 per a/u	Cash expenditure, primary data, CD 15
WCAF-2	27.00 per a/u	Cash expenditure, primary data, CD 15
WCAF-3	29.00 per a/u	Cash expenditure, primary data, CD 15
WFDR-1	30.00 per a/u	Cash expenditure, primary data, CD 15
WFDR-2	32.00 per a/u	Cash expenditure, primary data, CD 15
WFDR-3	34.00 per a/u	Cash expenditure, primary data, CD 15
SCOW-1	5.77 per a/u	Cash expenditure, primary data, CD 15
SCOW-2	5.77 per a/u	Cash expenditure, primary data, CD 15
SCOW-3	5.77 per a/u	Cash expenditure, primary data, CD 15
SYLG-1	3.00 per a/u	Cash expenditure, primary data, CD 15
SYLG-2	3.00 per a/u	Cash expenditure, primary data, CD 15
SYLG-3	3.00 per a/u	Cash expenditure, primary data, CD 15
SFDR-1	3.00 per a/u	Cash expenditure, primary data, CD 15
WCULCWSL	150.00 per head	ADA, 1975 average price
SYG-1VAD	100.00 per head	Estimated value added
SYG-2VAD	125.00 per head	Estimated value added
SYG-3VAD	150.00 per head	Estimated value added
SYG-1SL	100.00 per head	ADA, 1975 average price
SYG-2SL	125.00 per head	ADA, 1975 average price

Appendix 7. Continued

Column Activity	Figure Used ($)		Source
SYG-3SL	150.00	per head	ADA, 1975 average price
SYG-1SL	100.00	per head	ADA, 1975 average price
SYG-2SL	125.00	per head	ADA, 75 average price
SYG-3SL	150.00	per head	ADA, 1975 average price
FATBEFSL	250.00	per animal	ADA, 1975 average price
SCULCWSL	150.00	per animal	ADA, 1975 average price
BULL-SL	200.00	per bull	ADA, 1975 average price
SCOWVAD	190.00	per head	Estimated value added
SCAFVAD	50.00	per head	Estimated value added
SCAFSL	50.00	per head	ADA, 1975 average price
SFDR-1SL	200.00	per head	ADA, 1975 average price
RPC-SL	150.00	per head	ADA, 1975 average price
WCAF-1SL	50.00	per head	ADA, 1975 average price
WCAF-2SL	65.00	per head	ADA, 1975 average price
WCAF-3SL	80.00	per head	ADA, 1975 average price
B-CASH	44-00	per($000)	Estimated interest 8% (bi-yearly)
B-LONG	70.00	per($000)	Estimated interest at 7% (yearly)
LGT-BAL	1000.00		Estimated long term balance
SOW-UN	71.17	per a/u	Cash expenditure, primary data, CD 15
SOW-BT	18.93	per cwt	ADA, 1975 average price
BOR-BT	42.09	per cwt	ADA, 1975 average price
WEN-SD	65.25	per cwt	ADA, 1975 average price
HOG-SD	65.25	per cwt	ADA, 1975 average price
CSOW-S	23.85	per cwt	ADA, 1975 average price
HAY-PN	3.25	per acre	Cash expenditure, primary data
P-T-PN	2.64	per acre	Estimated pasture cost
BOR-SD	12.50	per cwt	ADA, 1975 average price

Appendix 7. Continued

Column Activity	Figure Used ($)	Source
P-N-PN	1.00 per acre	Estimated pasture cost
HAY-PR	35.00 per ton	ADA, 1975 average price
GRNFEED	5.25 per ton	ADA, 1975 average price

Appendix 8: Technology Model of Northern Alberta: Alphabetical Row and Column Name Abbreviations

A-EST 1+2	Alfalfa establishment-land class 1 and 2 (acres)
A-EST 3	Alfalfa establishment-land class 3 (acres)
A-EST 4	Alfalfa establishment-land class 4 (acres)
ALF 3	Acres in alfalfa-land class 3
ALF 4	Acres in alfalfa-land class 4
ALFA-IN	Alfalfa inventory (Feed) in tons
ALFA-INP	Alfalfa inventory (Plant) in tons
ALF-PR 1+2	Alfalfa production-land class 1 and 2 (acres)
ALF-PR 3	Alfalfa production-land class 3 (acres)
ALF PR 4	Alfalfa production-land class 4 (acres)
ALFA-SL	Alfalfa sale (Feed)
ALFA-SP	Alfalfa sale for plant
AR-AC	Arable acres
B-CASH	Borrow cash annually ($)
B-LONG	Long-term borrow ($)
BLY 1+2	Barley production-land class 1 and 2,fallow acres
BLY 1+2S	Barley production-land class 1 and 2,stubble
BLY 3F	Barley production-land class 3,fallow
BLY 3S	Barley production-land class 3,stubble
BLY 4F	Barley production-land class 4,fallow
BLY 4S	Barley production-land class 4,stubble
BLY-IN	Barley inventory
BLY-SO	Barley seed transfer and bought
BOR-EQ	Borrowable equity
BOR-SD	Boars sold
BOR-TR	Boar transfer
BORTRANS	Borrow transfer
BRY-SD	Barley purchased
BRY-SL	Barley sold

Appendix 8. Continued

BULL-INV	Bull inventory
BULL-SL	Bulls sold
BULL-TR	Bull transfer
C-OUT	Cash outlay
COP-IN	Chop inventory
COM-PAS	Community pasture
COM-SP	Combine service purchase
COM-PR	Combine purchase and purchase transfer
COM-SR	Combine service cost
COMU-IN	Community pasture inventory
CRC	Cash row-constraints (RHS)
C-SOW-S	Culled sows sold
C-SW-T	Culled sow transfer
FAL-AC	Fallow acres
FAL-IN	Fallow inventory
FAL-PN	Fallow production
FAL 1+2	Arable fallow acres-land 1 and 2
FAL 3	Arable fallow acres-land class 3
FAL 4	Arable fallow acres-land class 4
FATBEEF	1000 lb. animals
FATBEFSL	Sell 1000 lb. animal
GRN-ST	Grain storage transfer
GRNFEED	Green feed
GRNFD-IN	Green feed inventory
HAY-IN	Hay inventory
HAY-PN	Hay production
HAY-PR	Hay purchased
HAY-ST	Hay storage transfer
HOG-SD	Hogs sold
HOG-TR	Hog transfer
IP-PAS	Improved pasture

Appendix 8. Continued

P-T-PN	Tame pasture production
P-TRAN	Phosphorus transfer
RAD 1+2F	Rape production-land class 1 and 2 fallow (Acres)
RAP 1+2S	Rape production-land class 1 and 2 stubble
RAP 3F	Rape production-land class 3 fallow
RAP 3S	Rape production-land class 3 stubble
RAP 4F	Rape production-land class 4 fallow
RAP 4S	Rape production-land class 4 stubble
RAP-IN	Rape inventory
RAP-SD	Rapeseed inventory
RAP-SL	Rape sold
RAP-SP	Rapeseed purchase
RCF	Cash outlay
RPCINV	Replacement cattle inventory
RPCSL	Replacement cattle sold
SCAFSL	Summer calf sale
SCAFVAD	Summer calf value added
SCOW-1	Summer cow on tame pasture
SCOW -2	Summer cow on native pasture
SCOW-3	Summer cow on community pasture
SCOWINV	Summer cow inventory
SCULCWSL	Sell summer cull cow
SFDR-1	Summer feeder (2 year old) native pasture
SFDR-SL	Sell summer feeder
SHORTLIM	Short limit borrowings
SOW-BT	Sows bought
SOW-RP	Sow replacement units
SOW-UN	Sow units
STR-GR	Store grain
STR-HY	Store hay

Appendix 8. Continued.

K-FERT	Potassium fertilizer
K-TRAN	Potassium transfer
L-J A	Labour use July and August
L-M J	Labour use May and June
L-N A	Labour use November to April
L-S O	Labour use September to October
L-TOTL	Total labour use
LGT-BAL	Long term balance ($)
LGT-EQ	Long term equity
LTR-PR	Largest tractor pruchase
LTR-SP	Largest tractor service purchase
LTR-SR	Largest tractor service
LIVETIME	Time spent hauling and trading livestock
MTR-PR	Middle tractor purchase
MTR-SP	Middle tractor service purchase
MTR-SR	Middle tractor service
N-FERT	Nitrogen fertilizer
N-TRAN	Nitrogen transfer
NT-PAS	Natural pasture
NT-P-IN	Natural pasture inventory
OAT 1+2F	Oat production-land class 1 and 2, fallow (acres)
OAT 1+2S	Oat production-land class 1 and 2, stubble
OAT 3F	Oat production-land class 3, fallow
OAT 3S	Oat production-land class 3, stubble
OAT 4F	Oat production-land class 4, fallow
OAT 4S	Oat production-land class 4, stubble
OAT-IN	Oat inventory
OAT-SD	Oat seed
OAT-SL	Oats sold
P-FERT	Phosphorus fertilizer
P-N-PN	Native pasture production

Appendix 8. Continued

STR-IN	Straw inventory
STR-PR	Smallest tractor purchase
STR-SP	Smallest tractor service purchase
STR-SR	Smallest tractor service
STUB 1+2	Arable acres of stubble-land class 1 and 2
SUB 3	Arable acres of stubble-land class 3
STUB 4	Arable acres of stubble-land class 4
SWA-PR	Swather purchase
SWA-SP	Swather service purchase
SWA-SR	Swather service
SYG-1SL	Sell summer yearlings on improved (tame) pasture
SYG-2SL	Sell summer yearlings on native pasture
SYG-3SL	Sell summer yearlings on community pasture
SYG-1VAD	Summer yearlings on improved pasture (value added)
SYG-2VAD	Summer yearlings on improved pasture (value added)
SYG-3VAD	Summer yearlings on community pasture (value added)
SYLG-1	Summer yearlings on improved pasture
SYLG-2	Summer yearlings on native pasture
SYLG-3	Summer yearlings on community pasture
TA-P-IN	Tame pasture inventory
VAL-PR	Value of production
WCAF-1	Winter calf on low energy ration
WCAF-2	Winter calf on medium energy ration
WCAF-3	Winter calf on high energy ration
WCAF-1SL	Sell winter calf on low energy ration
WCAF-2SL	Sell winter calf on medium energy ration
WCAF-3SL	Sell winter calf on high energy ration
WCAF-INV	Winter calf inventory
WCAF-TR	Winter calf transfer
WCOW-1	Winter cow on low energy ration
WCOW-2	Winter cow on medium energy ration

Appendix 8. Continued

WCOW-3	Winter cow on high energy ration
WCOW-TR	Winter cow transfer
WCULCWSL	Winter cull cow sale
WEN-SD	Weiners sold
WENR-T	Weiners transfer
WFDR-1	Winter feeder on low energy ration
WFDR-2	Winter feeder on medium energy ration
WFDR-3	Winter feeder on high energy ration
WFDR-TR	Winter feeder inventory
WFDR-TR	Winter feeder transfer
WHT 1+2F	Wheat production-land class 1 and 2,fallow (acres)
WHT 1+2S	Wheat production-land class 1 and 2,stubble
WHT 3F	Wheat production-land class 3,fallow
WHT 3S	Wheat production-land class 3,stubble
WHT 4F	Wheat production-land class 4,fallow
WHT 4S	Wheat production-land class 4,stubble
WHT-IN	Wheat inventory
WHT-SD	Wheat seed transfer
WHT-SL	Wheat sold
WHT-SP	Wheat seed purchase

Appendix 9

Survey Questionnaire

Local Impact of Alfalfa and costs of Production

Coded Values

1. Location: Section ____ Township ____ Range ____ ________

2. Years of formal education: Man ____ Wife ____ ________

3. Year started farming 19____ ________

4. Year started farming on this land _____ ________

5. Number of family members between the age of:
    - Under 15 years ________
    - 15 -- 24 years ________
    - 25 -- 34 years ________
    - 35 -- 44 years ________
    - 45 -- 54 years ________
    - 55 -- 64 years ________
    - 65 : 69 years ________
    - over 70 years ________

6. Total area of land ________ acres ________

7. (a) Area owned ________ acres ________

    (b) Area rented (leased) ________ acres ________

    (c) Area rented out to others ________ acres ________

8. Total area of cultivated land ________ acres ________

    (a) Area under summer fallow ________ acres ________

    (b) Area under crops ________ acres ________

    (c) Area of improved pasture ________ acres ________

9. Area of unimproved native pasture ________ acres ________

10. Area of bush and unused land ________ acres ________

11. Area of new breaking ________ acres (1973/74) ______

12. Crop(s) planted in the area of new breaking ________

Crop and Livestock History

I. Acreages and yields for three years

	1972		1973		1974	
Crop	Acres	Yields	Acres	Yields	Acres	Yields
Wheat						
Barley						
Oats						
Summer fallow						
Mixed grains						
Rye						
Flaxseed						
Rapeseed						
Alfalfa						
Alfalfa mixtures						
Other tame hay						
Other crops						

2. Livestock Patterns:

	1971	1972	1973	1974
No. of beef cattle				
No. of beef cows				
No. of dairy cattle				
No. of dairy cows				
Number of sows				
Other				

Input/Output accounting for Alfalfa (on the basis of a selected 2 to 5 year old plot 10 acres or more in size)

Coded Values

First Year - Establishment and Maintenance:

1. Year planted 19____ ____________
2. Number of acres ______ ____________
3. Previous land use (fallow, grain etc.) __________ ____________
4. Type of mixture ______________________________ ____________
5. Type of cover crop ______________________________ ____________

Field operations	no. of men	man hours	tract. hours	tract. make	h.p.	age
6. 1st cultivation						
7. 2nd cultivation						
8. Harrowing						
9. Seeding						
10. Spraying						
11. Harvest of cover crop						
a) swathing						
Ib) combine						
c) baling						
d) raking						
e) transport & storage						
12. Other operations					–	

total tractor hours _____

total man hours _____

Production Expenses:	Kind	Rate/amt.	Price	
13. Seed: 1______ 2______ 3______ 4______ 5______				____________
14. Fertilizer: N P K				____________
15. Spray				____________
16. Hired labor				____________
17. Other inputs				____________

Coded Values

18. Yield of cover crop ________________ bu/tons/cwt

Second Year

Field operations	no. of men	man hours	tract hours	tract make	h.p.	age	
19. Cutting/swathing							
20. Raking							total tractor hours____
21. Baling/chopping							total man hours ____
22. Transport and storage							

Production Expenses	Kind	Rate/amt.	Price	
23. Fertilizer: P				____
K				____
24. Spray				____
25. Twine				____
26. Hired labour				____
27. Other inputs 1______				____
2______				____
3______				____

Harvested Alfalfa	tons	price
28. Yield of alfalfa		
29. Use of harvested alfalfa:		
a. Use on farm		
b. Sold to another farm or dealer		
c. Delivered to dehydration plant		

Third Year

Coded Values

Field operations	no.of men	man hours	tractor hours	tractor make	h.p.	age
30. Cutting/swathing						
31. Raking						
32. Baling/chopping						
33. Transport and storage						

total tractor hours _____,
total man hours _____

Production expenses	Kind	Rate/amt.	Price	Coded Values
44. Fertilizer: P				_____
K				_____
35. Spray				_____
36. Twine				_____
37. Hired labour				_____
38. Other inputs 1_____				_____
2_____				_____
3_____				_____

Harvested Alfalfa	tons	price	Coded Values
39. Yield of Alfalfa			
40. Use of harvested alfalfa			
a. Use on farm			
b. Sold to another farmer or dealer			
c. Delivered to dehydration plant			

41. Background Information:

1. How many acres were seeded to alfalfa in 1974?

2. Do you intend to expand alfalfa in 1975?

3. How do you determine the price at which to sell?

4. Are you satisfied with the present pricing system?

5. Do you prefer contract arrangements for your alfalfa?

6. What kind of contract arrangements do you prefer?

.. what problems do you usually expeience as an alfalfa grower?

8. In your opion has there been a shift to more alfalfa in neighbouring farms since the plant started?

Coded Values

9. If there is a shift, is it in addition to previous enterprises or is alfalfa replacing some crops or livestock?

10. What changes on your farm could you say have been made because of your alfalfa production over the last five years?